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SITE CHARACTERIZATION REPORT
FOR THE
BUCKEYE MINE SITE

Madison County, Montana

Prepared For:

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1.0 INTRODUCTION

This document was prepared for the Montana Department of Environmental Quality/Mine Waste Cleanup Bureau (DEQ-MWCB) by Olympus Technical Services, Inc. (Olympus) under DEQ Contract No. 401026. This report presents the results of Olympus' work on the Buckeye Mine site characterization of the mine/mill waste areas identified in the Mill Creek drainage basin.

A Reclamation Work Plan was prepared for the Buckeye Mine site in March 2004 (DEQ-MWCB/Olympus, 2004). The work plan was prepared to be a functional guide for conducting the full-scale reclamation at the Buckeye Mine site. Existing data available for this site were evaluated and preliminary risk analysis and a CERCLA Phase I and Phase II Feasibility Study (FS) have been performed and are presented in this work plan. A detailed site characterization study of the Buckeye Mine site was required to provide information for the Engineering and Economic Analysis necessary for assessing remedial alternatives and the preferred remediation option for the site. The site characterization work was completed according to the sampling approach for the Buckeye Mine as described in the Field Sampling Plan (DEQ-MWCB/Olympus, 2004a), which contain the Standard Operating Procedures (SOPs) for conducting the field sampling activities. Supporting documents for the site characterization include the Quality Assurance Project Plan (QAPjP) that describes quality assurance procedures for the field and laboratory data for the project (DEQ-MWCB/Olympus, 2004d), the Health and Safety Plan that describes practices and procedures to minimize exposure to hazardous materials and to reduce the possibility of physical injury (DEQ-MWCB/Olympus, 2004b), and the Laboratory Analytical Plan (DEQ-MWCB/Olympus, 2004c).

1.1 PROJECT DESCRIPTION

The Buckeye Mine site (PA# 29-451) is an inactive hardrock mine/mill site currently ranked No. 19 on the Montana Department of Environmental Quality, Mine Waste Cleanup Bureau (DEQ-MWCB) Priority Sites List.

The Buckeye Mine is located near the town of Brandon, Montana, approximately 3 miles east-northeast of the town of Sheridan in Madison County, Montana. The site is located within the E½, SE ¼ of Section 19 and the NW¼, SW¼ Section 20, Township 4 South and Range 4 West, Montana Principal Meridian (Figure 1-1). Figure 1-2 is an aerial orthophotograph taken in August 1995 that shows an overview of the site area. The site is located within the Mill Creek drainage, a tributary of the Ruby River. The site is accessible by taking Montana Highway 287 to Sheridan, turning east onto Mill Creek road and proceeding approximately 3 miles to Brandon. The lower portion of the site (TP-4 and WR-5) is located along Mill Creek at Brandon. What is believed to be the former Brandon Mill is located across Mill Creek Road from tailings pile TP-4 (Figure 1-2). The upper portion of the site is located approximately ¼-mile to the northeast in an unnamed, ephemeral tributary to Mill Creek. The upper portion of the site is accessed via a gravel road at the west edge of Brandon.

The Buckeye Mine is located mostly on patented mining claims within public lands managed by the Bureau of Land Management (BLM). A small portion of the site is on public lands managed by the BLM. The site is comprised of five tailings ponds, five waste rock piles, a small building, an ore chute/loadout structure and the former Brandon Mill area. Three of the tailings piles and four of the waste rock piles are located near an unnamed ephemeral drainage. The fourth tailings pile and fifth waste rock pile are located on the south and north banks of the perennial

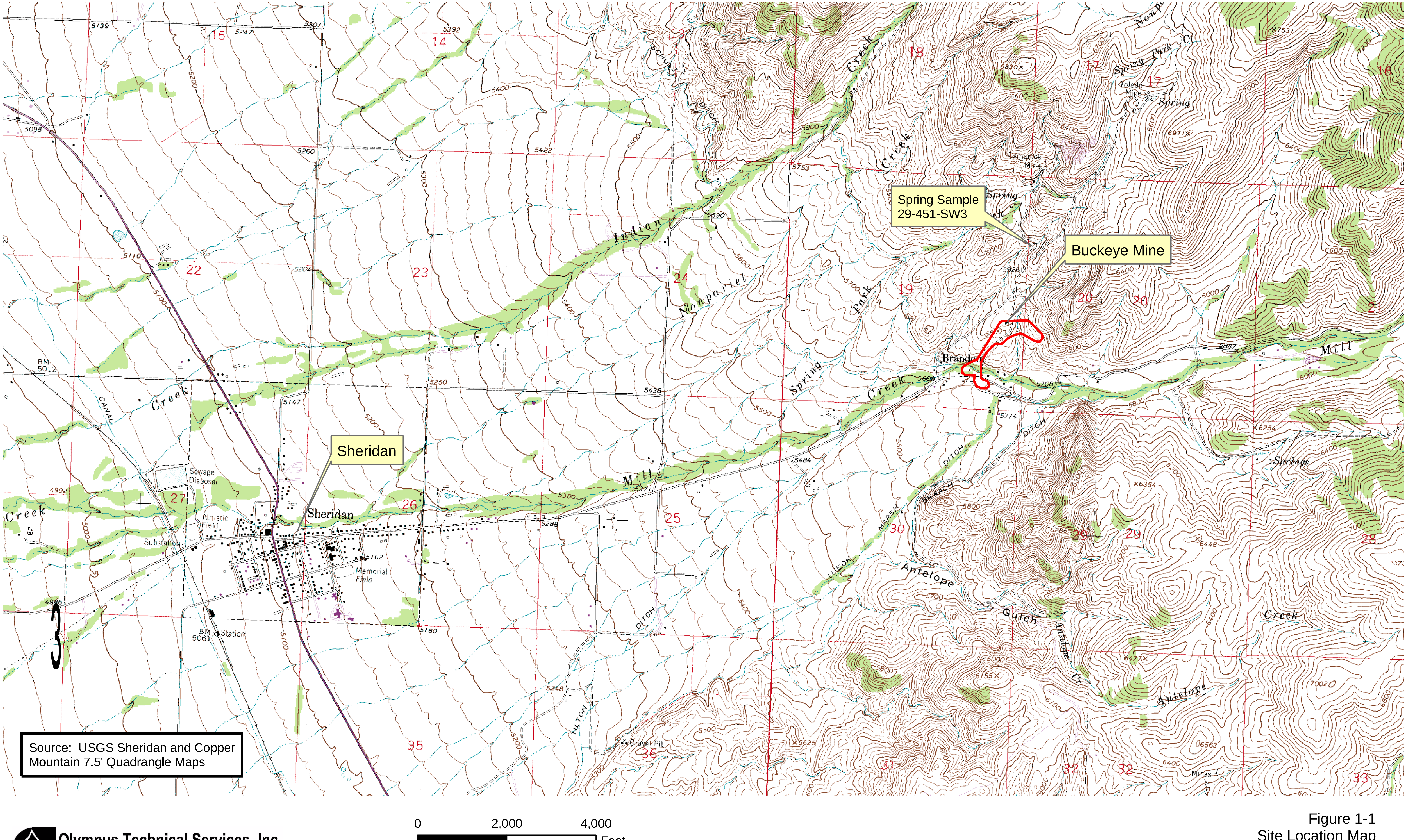

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Figure 1-1
Site Location Map

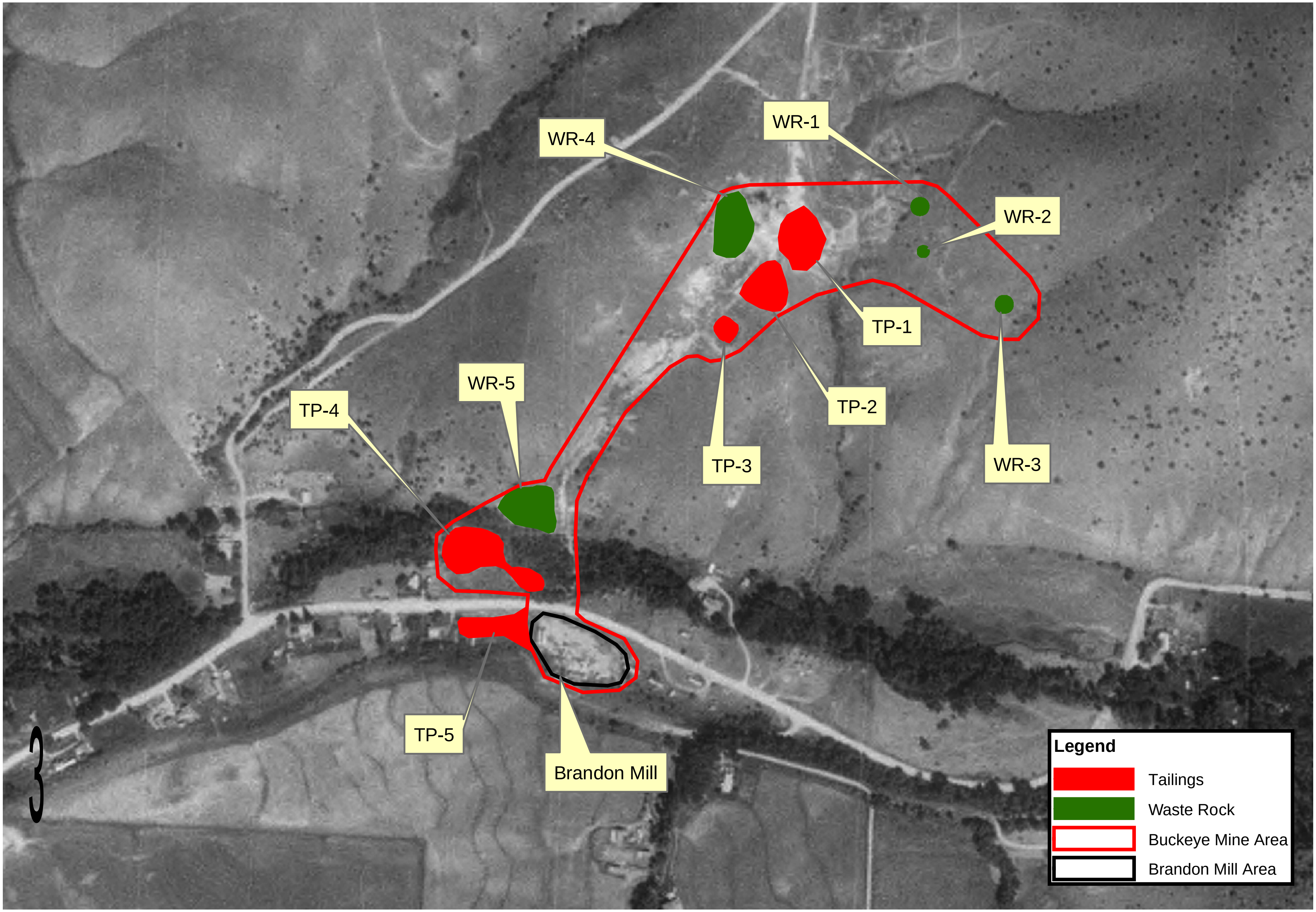

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Figure 1-2
Aerial Photograph of the
Buckeye Mine Area

stream, Mill Creek, respectively. The Brandon Mill and a small tailings pile TP-5 are located on the south side of Mill Creek, across Mill Creek Road from the remainder of the site.

1.2 PROJECT OBJECTIVES

The objective of the site characterization is to collect sufficient data to perform a risk assessment and detailed analysis of reclamation alternatives for the Buckeye Mine including the Brandon Mill site. The data required to support each of these tasks are summarized as follows:

Risk Assessment Data Requirements:

- Establish background soil concentrations with at least 5 background samples;
- Characterize vertical and lateral metal concentration variations in waste sources and assess the 0 to 6 inches zone for direct contact and air emission potential;
- Evaluate the physical and chemical properties of the source material that may affect contaminant migration including: pH, metal concentrations, leaching potential, acid/base accounting, and particle size distribution;
- Inventory solid and hazardous waste materials on site associated with past mining operations;
- Assess physical hazards associated with potential open adits or shafts, pits, trenches, highwalls, and dilapidated structures, etc; and
- Assess surface water and groundwater uses and water quality.

Feasibility Study Data Requirements:

- Accurate areas and volumes of the contaminant source materials (mill tailings and waste rock);
- Contaminant concentration variations and leaching characteristics of the waste;
- Groundwater characteristics in the vicinity of potential repository areas and water quality of private domestic wells that are potentially at risk;
- Physical characteristics and dimensions of open accesses to underground mine workings (if any);
- Revegetation parameters for cover soil sources including soil texture and grain size, nitrogen, phosphorus, potassium, percent organic matter, pH, and conductivity;
- Hydrologic configuration of Mill Creek in the vicinity of the tailings and waste rock piles;
- Optional locations and soil characteristics for repository sites; and
- Identification of potential borrow source areas for cover soil.

2.0 BACKGROUND INFORMATION

2.1 MINING HISTORY

The Sheridan mining district includes all mining properties on the west slope of the Tobacco Root range from Wisconsin Creek south to California and Bivins gulches inclusive (Tansley, et al., 1933). The mining properties and the Brandon Mill located in the Mill Creek drainage are considered part of the Sheridan mining district. Early development in the Sheridan region closely followed the discovery of gold in Alder Gulch in 1863.

The following discussion is taken directly from the historical narrative summary of the Sheridan mining district and the Buckeye mine compiled by the Montana Department of Environmental Quality (MTDEQ, 2003). Alfred Cisler, one of the first settlers of the town of Brandon, discovered the Buckeye mine in the 1860s. The Brandon mill was the first mill to be erected in the Sheridan district. The mill was constructed in 1865, had 12 stamps of 500 pounds each and processed 12 tons of ore per day. Mill production in the early years was limited due to the use of water power to drive the stamps.

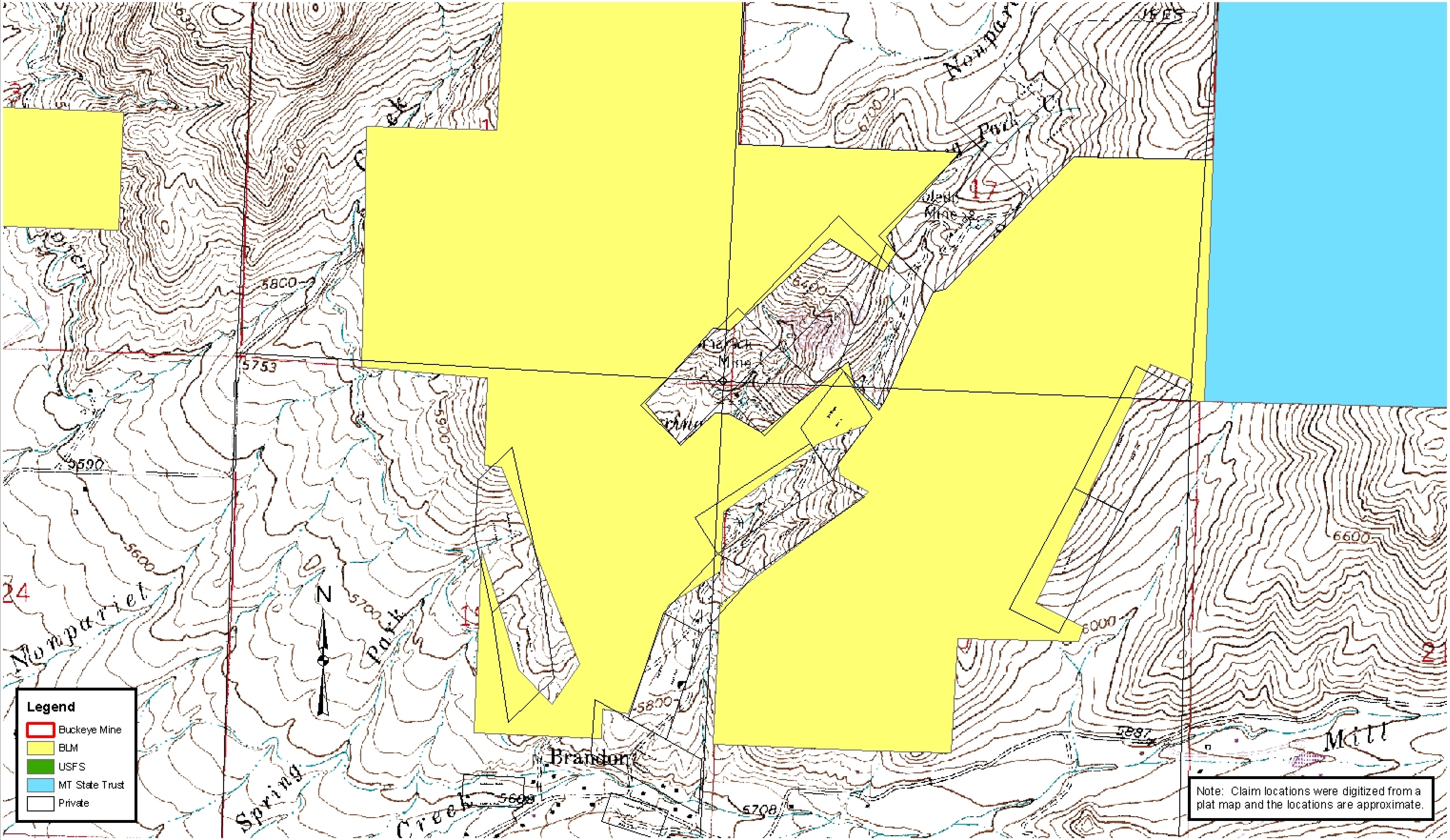
The Buckeye property is composed of five locations on the same vein and three of the group were patented: the Buckeye, the Buckeye #1, and the Buckeye #5. The claims were formally located in January of 1883 and were surveyed for patent in March of 1896. Henry Elling, Virginia City general store owner turned mining magnate, owned the property at the time of the survey which listed $3,930 in tunnels, shafts, and levels. Figure 2-1 shows the generalized land ownership and mining claims in the vicinity of the site.

The Buckeye claims showed surface mineralization their entire length of the 600 foot vein. When George Cope visited the site in the mid 1880s, he noted that the entire surface could be mined with a scraper and run through concentrating jigs. To dig anywhere on the claim was to find ore. He predicted the true value of the mine was as a large producer of low-class ore (Cope, 1888).

In 1896 the property, which was owned by Henry S. Gilbert et al., was one of the three best developed mines in the district, and was being developed by David Fifer of Butte, who took a lease and a bond on the mine. By 1898, Fifer had excavated the shaft to 70 feet where he struck a fine vein of galena and carbonate ore. The shaft, which was sunk entirely in ore, dropped to the 100 foot level before developing a system of levels and cross cuts. In May of 1898, Fifer began to run the concentrator in the Brandon entirely on Buckeye ore. In July he freighted 35 tons of galena to Twin Bridges to be shipped by rail to the smelter in East Helena (Western Mining World passim).

The mine continued to be developed by a series of lessees. In 1899, O.S. Brooks and John Merrill leased the mine and were reported to be taking out good ore. In March of 1900, Cavanaugh and McDonald leased the property and sent ore to the Twin Bridges Smelter. Later the same year Wiseman and Co. shipped ore from the mine to East Helena. Although the mine was listed as one of the district's most developed in 1902, the mine saw little further work until 1919 (Western Mining World passim).

Interest was renewed in the mine in 1916 when it was listed in the Mineral Record as a key producer in the district. However, production did not resume until 1919 when several lots were shipped from the mine. The next year it briefly resumed its role as one of the district's largest



0 1,000 2,000 Feet

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Figure 2-1
Generalized Land Ownership and Mining Claims in the Vicinity of the Buckeye Mine

producers before shutting down in 1921. In 1924, development resumed under the recently organized Buckeye Corporation as several lots of sulfide ore were shipped from the mine. In 1925, the mine's lessees shipped lead-zinc ore to the Timber Butte plant in Butte. Although the mine was only active for 30 days, it was the district's leading producer and the lessees opened up a large body of ore. The 1926 season saw the mine still under lease and shipping ore to the Timber Butte Plant from January to March. Although the Buckeye Corporation ended its active role in the operation of the mine in 1927, new lessees shipped several cars of lead-zinc ore to Butte in 1928. By 1929, the mine had risen to become the chief producer in the district (Mineral Record, 1916 - 1929; Trauerman, 1950).

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In 1929, the Vigilante Mining Corporation (VMC) began serious development of the property. Organized in August of 1929 with Texas capital and with A.H. Dahle as President, the company was reported to be remodeling the mill at the Buckeye (probably the Brandon Mill). A 75-ton concentrating table and flotation plant was ordered from the Butte Machinery Co. and installed by September. By October, VMC was reported to be working the mine dump and by the end of the year had reduced 2,648 tons of material to 344 tons of lead concentrate. In addition, several cars of lead-zinc were shipped to Butte. In 1930, the mine was listed as one of the chief producers of lead in Montana. Operations, including both the Brandon Mill and the lead-zinc ore shipments to Butte, were suspended in June of 1930 (Mining Truth 1929; Mining Journal 1929; Mineral Record 1929; 1930).

Because the Stock Market crash of October 1929 and the following Great Depression reduced both mining speculation and the government's ability to report on mineral production, the mine disappeared from both the trade journal and government reports. In 1933, Wilfred Tansley described the mine's development as two adits which had been extended over 600 feet on the vein. He noted that a portion of the Buckeye ore body was stoped and the ore concentrated at the Buckeye Mill. He also reported that the collapse of mineral prices had brought an end to production (Tansley, et al., 1933).

Yet with a huge body of low-grade ore, the mine continued to interest developers. From 1944 to 1948, the Buckeye Corporation leased the property to Victoria Mines, Inc. who operated the mine. The mine and mill were most recently operated by Steve Mortensen until 1983. The mine was worked with front-end loaders, loaded into trucks, crushed with a ball mill and the concentrate was shipped to East Helena for final treatment.

2.2 CLIMATE

There are no official weather stations in the Mill Creek drainage. The nearest official weather stations to the Buckeye Mine are located in Twin Bridges and Virginia City, Montana. National Oceanic and Atmospheric Administration's Western Regional Climate Center has compiled temperature and precipitation data at Twin Bridges (248430) and Virginia City (248597), Montana for the periods June 1, 1950 through December 31, 2002 and July 1, 1948 through December 31, 2002, respectively.

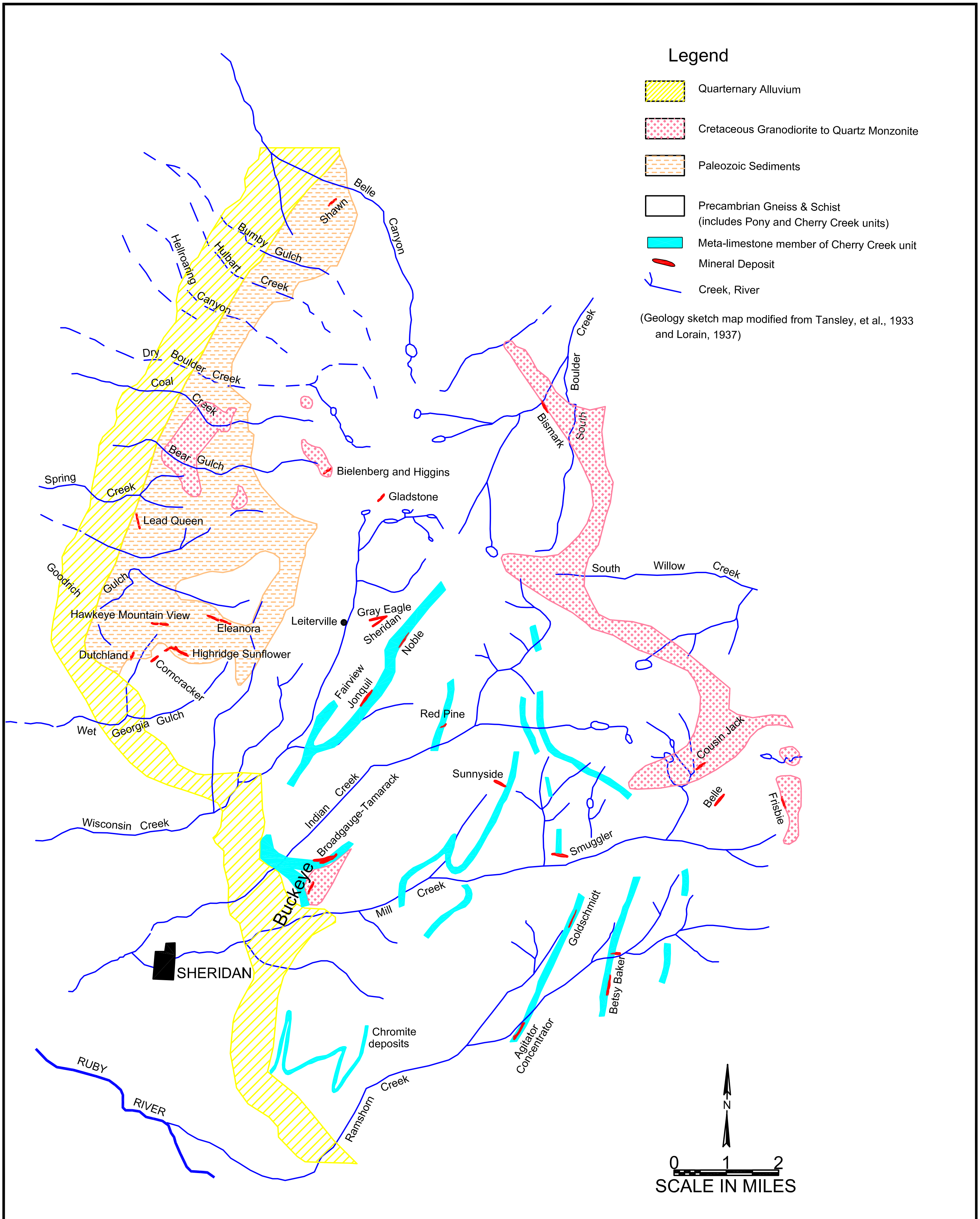
These appear to be the closest official weather stations to the Mill Creek drainage. Twin Bridges and Virginia City are approximately 12 miles northwest and 16 miles southeast of the Buckeye Mine site, respectively. The average annual maximum and minimum temperatures recorded at the Twin Bridges site were 58.3 degrees Fahrenheit (°F) and 27.9°F, respectively. The average annual maximum and minimum temperatures recorded at the Virginia City site were 55.2°F and 29.2°F, respectively. The average annual total precipitation for the Twin Bridges and Virginia City sites is 9.57 and 15.64 inches, respectively. The lowest and highest average precipitation occurs in the months of January/February and May/June, respectively. Average annual total snowfall is 10.3 and 63.8 inches for Twin Bridges and Virginia City, respectively. Most snow falls from November through April.

Like most of southwestern Montana, the Mill Creek drainage is subject to a cool and dry continental-dominated climate. The temperature of the region is marked by wide seasonal and daily variations. During winter, the temperature can fall lower than 30 degrees below zero Fahrenheit. During summer, many days reach the 80's and 90's but due to the generally arid climate and lightness of the mountain air, the temperature can drop substantially at nightfall. Stormy weather usually brings the first snow during September, however, these "equinoctial storms" are generally succeeded by several weeks of fair weather. By November, the area is usually blanketed with snow. Heavy snows are frequent in the winter as are periods of melting and freezing which occur as a result of warm Chinook winds that occasionally blow from the west.

2.3 GEOLOGY, HYDROGEOLOGY, AND HYDROLOGY

The geologic mapping available for the southwestern portion of the Tobacco Root Mountains is generally limited to reconnaissance scale. A preliminary geologic map of the Dillon 1°x2° quadrangle was prepared by Alt and Hyndman (1978). This small scale map summarized earlier reconnaissance mapping completed by others. The reconnaissance geologic mapping completed by Tansley, et al. (1933) provides the most detail relative to the geologic setting of greater Sheridan mining district area which hosts the Buckeye Mine site. A geologic sketch map (Figure 2-2) modified from Tansley, et al. (1933) and Lorain (1937) depicts the general geology, known mineral deposits and drainage pattern in the greater Sheridan Mining district, which includes the Sheridan and Tidal Wave mining districts.

The principal country rocks of the Sheridan mining district are the Precambrian metamorphic rocks identified as the Cherry Creek and Pony gneisses and schists. These metamorphic rocks are the oldest rock units in the area and the Pony gneiss is believed to be older than the Cherry Creek gneiss. The contact between the Pony and Cherry Creek units is generally not distinct and these units have not been differentiated in the geologic map presented in Figure 2-2.



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Geologic Sketch Map
Greater Sheridan Mining District Area

FIGURE 2-2

According to Reid (1957) who completed more detailed mapping in the northern portion of the Tobacco Root Mountains, differentiation of the two units can only be made by observing the intermixed layers over a 500 to 1,000 feet section. The principal metamorphic rocks in these units include leptite, gneiss and amphibolite. The Cherry Creek unit contains similar main layers of leptite, gneiss and amphibolite, but is characterized by intermixed layers of marble (meta-limestone), thick greenish quartzite, sillmanite schist or coarse garnet amphibolite. Tansley, et al. (1933) noted that the occurrence of limestone in the Cherry Creek unit is more extensive in this region than anywhere else in the Tobacco Root Mountains and these limestones have been important in localizing orebodies. The Cherry Creek gneiss appears to be the dominant Precambrian metamorphic unit in the Sheridan mining district based on the more widespread occurrence of meta-limestone. Paleozoic sedimentary rocks, consisting of quartzites, shales and limestones, generally occur along the boundary area of the Tobacco Root Mountains. In the greater Sheridan mining district area, Paleozoic sedimentary rocks are present only in the northwestern portion. The principal intrusive rock in the Tobacco Root Mountains is a Cretaceous-age batholith comprised predominantly of granodiorite and lesser quartz monzonite (Reid, 1957). The batholith is generally an even-grained to porphyritic, massive light-gray rock composed of plagioclase, quartz, and microcline with minor biotite and hornblende. Zircon, allanite, magnetite, sphene and apatite are the principal accessories. In the greater Sheridan mining district area, the western edge of the Tobacco Mountain batholith occurs in the higher elevations in the area of the headwaters of Indian and Mill Creeks. Smaller plutons, possibly apophyses of the batholith, are present in the district (Figure 2-2), as are felsic and mafic sills and dikes. Some of these sills and dikes show a spatial relationship to some of the ore deposits identified in the greater Sheridan mining district (i.e., Strawn, Noble, Dutchland, Corncracker). The youngest geologic unit in the area is Quaternary alluvium which forms creek and river deposits and valley terrace deposits.

Few details are available on the structural geology of the greater Sheridan mining district area. The contorted meta-limestone beds in the Cherry Creek gneiss indicate that the Precambrian rocks have been subjected to considerable compressional tectonics resulting in folding. Most orebodies in the district appear to be related to extensional tectonics that have produced fault and shear zones.

The reports by Tansley, et al. (1933) and Lorain (1937) provide information on the economic geology and individual mine sites. The following discussion is based principally on these references. The chief primary minerals of the greater Sheridan district are pyrite, arsenopyrite, chalcopyrite, sphalerite, and galena, all in a gangue of quartz and rarely siderite. The sulfide minerals vary in concentration from one mine to the next in the district and generally do not show any significant mineral zoning pattern. The Sheridan and Tidal Wave district deposits are predominantly lead and zinc with lesser precious metals. The highest ratio of silver to gold and most of the silver-bearing sulfides are found in the veins of Virginia City, Sheridan, Tidal Wave and Renova districts.

The veins are mainly of the fissure filling type, but in the Sheridan district, limestone replacements are of great importance. Thus, the ore-shoots of the Red Pine, Sunnyside, Smuggler, Fairview, Tamarack, Broadgauge, Betsy Baker, Goldsmith, Agitator, and many others are within or are controlled by Precambrian limestone members. The orebodies are both concordant and discordant to banding in the metamorphic rocks. In general, the veins are not related to strong structural fissures, and movement is relatively small. According to Tansley, in 1933, some of the larger veins that appeared to be associated with structural zones were observed at the Lake Shore, Gray Eagle, Noble, Fairview, Sunnyside, Smuggler, Buckeye (in granodiorite), and Betsy Baker mines.

Fissure veins occupy bedding plane faults in limestone and a few, in other sedimentary rocks. The veins in limestone may or may not be accompanied by replacement of the wallrock. Oreshoots are frequently pipelike or very irregular; their strength appears to depend upon the strength of shearing. The deposits are hosted predominantly within the Precambrian gneisses, but some are contained exclusively in the Paleozoic sedimentary rocks (i.e. Tidal Wave district) or in the granodiorite to quartz monzonite intrusive rocks (i.e. Buckeye, and Cousin Jack deposits). The Buckeye, Smuggler and Corncracker mine ores consist of impregnations and veins of heavy sulfides along crushed and sheared zones in igneous intrusives or gneiss. The orebodies in the Broadgauge-Tamarack mine are impregnations and replacements along a strong sheared and crushed zone in limestone.

The intensity of wallrock alteration in the Sheridan district varies greatly in the different deposits. Alteration associated with the vein deposit host rocks at the Gray Eagle, Fairview, Broadgauge-Tamarack, Buckeye, Sunnyside, Smuggler, and Betsy Baker generally consists of sericitization and silicification. The host rocks in these deposits also show rather strong fissuring. Also in the Broadgauge-Tamarack deposit, a light, cellular, siliceous sinter-like mass containing alunite and fine gold is developed after limestone. Most of the mining in the district has been conducted in near surface oxide-rich zones that appear to show some secondary enrichment for precious metals, especially gold. It has been reported that the important production from the Noble, Gray Eagle, Agitator, Belle and many others was probably derived from the enriched concentrations of gold in the oxidized, upper sulfide zone. The normal gold content of the hypogene or primary sulfide zone is reported to be considerably less than the oxide zone.

2.3.1 Local Geologic Setting

Few details are available on the geology of the Buckeye Mine. Tansley, et al. (1933) provides a summary of the mine geology and mineralization. The mine is opened by two adits, the lower of which has been extended more than 600 feet as a drift on the vein trending N30°E and dipping 20° to 35° W. During 1933, the Buckeye mine to date was developed entirely within the igneous intrusive Brandon granite (granodiorite). The vein is hosted in a shear zone within the granodiorite and the contact between the granodiorite and the Cherry Creek gneiss lies roughly parallel to the vein zone, and is only 70 to 80 feet in the hanging wall of the vein. The Buckeye fissuring is quite strong and comprises a series of strong faults throughout some 30 feet or more in width. The mineralization is of the replacement type and consists of auriferous pyrite, argentiferous galena, sphalerite, and chalcopyrite disseminated with quartz throughout the wide fissure zone. Alteration has been intense as sericitization and silicification, and sulfides in the near surface are almost completely oxidized. According to Tansley, et al. (1933), a portion of the Buckeye orebody was stoped and concentrated at the Buckeye mill as recently as the 1930's, and was stopped due to the collapse of metal prices.

2.3.2 Hydrogeology

Based on a review of standard hydrogeologic literature sources, no published hydrogeologic information specific to this area has been prepared. The interpretation of hydrogeologic conditions presented here is based on accepted hydrogeologic principals, local observations and available geologic information. The Buckeye Mine waste sources are located within the drainage basin of Mill Creek, a tributary to the Ruby River.

The hydrogeologic system contains two main components, bedrock and alluvial valley fill. The bedrock is comprised of metamorphic and igneous rocks that are moderately fractured and contain vein structures. The vein structures are associated with the intrusion of a granitoid pluton and older fractures related to folding and faulting of the Precambrian metamorphic rocks. Other potential bedrock controls on groundwater movement include pre-metamorphic bedding structures, unconformities, and joints. Due to the complex and unpredictable nature of the bedrock structures, it is likely that the rate and direction of groundwater flow is widely variable over short distances. Permeability and transmissivity of the bedrock aquifer system probably vary widely. The alluvial deposits are thin, shallow, and discontinuous and likely transmit both surface water from local streams and discharging bedrock groundwater.

Groundwater flow likely follows local stream gradients and topography, with groundwater discharging to gaining alluvial streams which is typical of mountain drainage systems. However, local bedrock fault systems and secondary solution features associated with meta-limestones probably exert significant control on the direction and rate of groundwater flow, as do the underground workings associated with the mines in the area.

2.3.3 Surface Water Hydrology

The Buckeye Mine occurs within the Mill Creek drainage (Figure 2-3). The site is located approximately 11.3 miles above the confluence of Mill Creek and the Ruby River. Tailings TP-4 and waste rock WR-5 piles are adjacent to the banks of Mill Creek. The Brandon Mill is located on the south side of Mill Creek, near tailings pile TP-4. Tailings piles TP-1 through TP-3 and waste rock piles WR-1 through WR-4 are located above the Mill Creek floodplain near an unnamed, ephemeral tributary. Mill Creek discharges into the Ruby River approximately 11.3 miles below the lower-most tailings pile (TP-5).

The peak discharges for Mill Creek in the vicinity of the Buckeye Mine were estimated using regional flood-frequency equations (Omang, 1992) and are presented in Table 2-1. The flood-frequency equations for the southwest region of Montana are based on the drainage area (23.85 square miles) and the percentage of the basin area that is above 6,000 feet in elevation (97.47 percent).

TABLE 2-1 ESTIMATES OF PEAK DISCHARGE FOR MILL CREEK AT THE BUCKEYE MINE

Recurrence Interval (years)	Peak Discharge (cfs) by Regional Flood-Frequency Equations
2	95
5	158
10	217
25	295
50	352
100	412

In the area above the site, Mill Creek flows through a narrow valley with steep side slopes. At Brandon, Mill Creek emerges from the narrow valley and flows over an alluvial fan until it reaches the Ruby Valley, approximately 5.5 miles northwest of Sheridan. The average stream

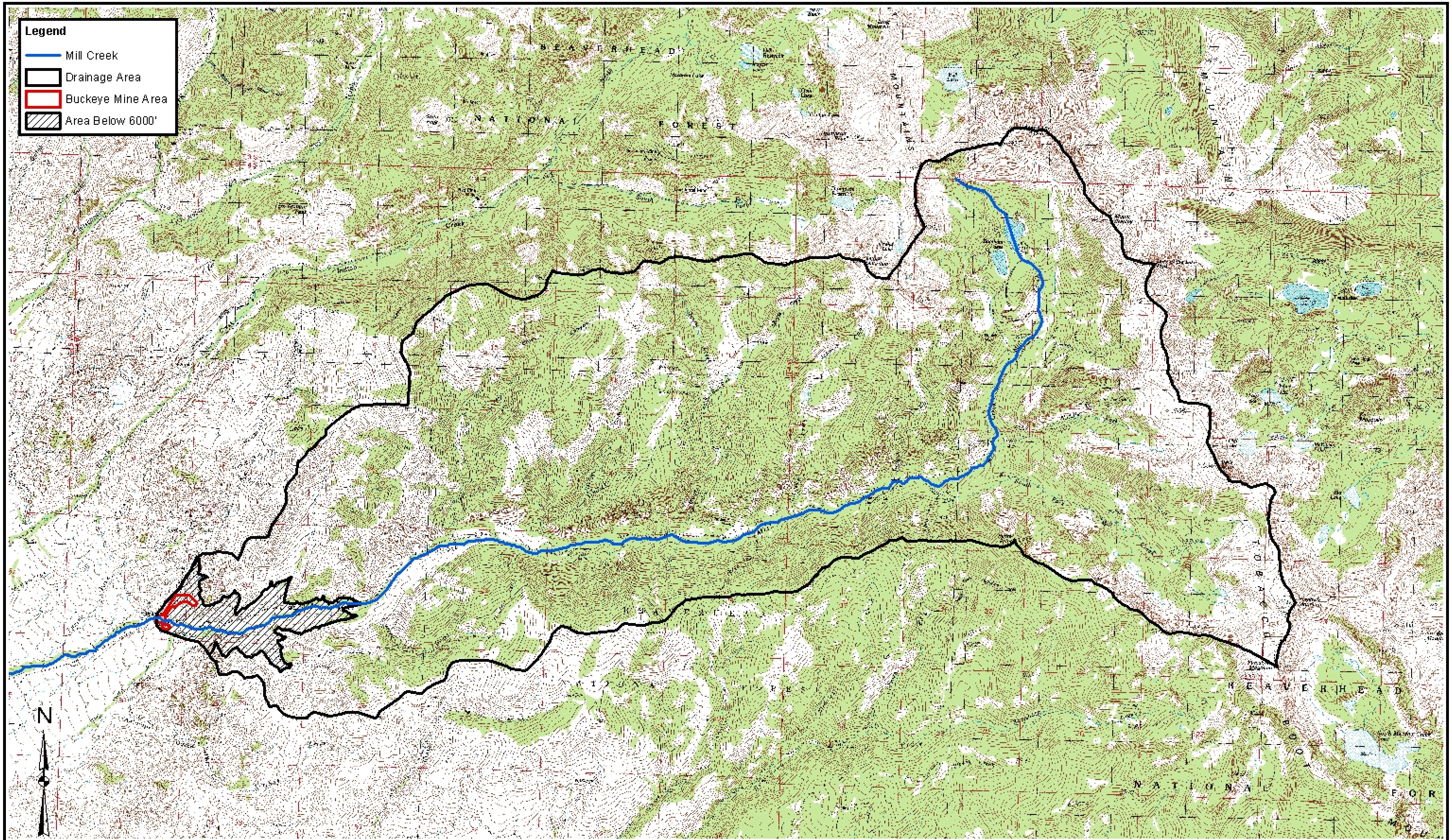

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Figure 2-3
Mill Creek Drainage Area Map

gradient through the site area is approximately 3.4 percent. The average stream gradient above the site is approximately 6.4 percent. The average stream gradient on the alluvial fan below the site is approximately 2.3 percent.

2.4 CURRENT SITE SETTING

2.4.1 Location and Topography

The Buckeye Mine is located in the Sheridan Mining District, Madison County, Montana. The site is located within the E½, SE ¼ of Section 19 and the NW¼, SW¼ Section 20, Township 4 South and Range 4 West, Montana Principal Meridian and the latitude and longitude are North 45° 28' 25" and West 112° 8' 10". The site is located in the Mill Creek drainage. The elevation of the site ranges from approximately 5,630 feet where Mill Creek flows through the site to 5,825 feet at the upper end. The topography of the basin is mountainous and is mostly forested. The peaks in the headwaters of Mill Creek (Branham Peaks) rise to over 10,200 feet. Branham Lakes, a pair of lakes at an elevation of approximately 8,800 feet, are formed in a cirque near the headwaters of the drainage. The town of Brandon is located on the eastern edge of the alluvial fan above the Ruby Valley. The land is used for wildlife habitat, livestock grazing, and recreation. The town of Sheridan is located approximately 3 miles west-southwest of the site.

2.4.2 Vegetation/Wildlife

The Final Environmental Impact Statement for the U.S. Forest Service (USFS) Tobacco Root Vegetation Management Plan (USFS, 2001) describes the vegetation cover in the southern Tobacco Root Mountains as grassland, sagebrush, and juniper with scattered patches of Douglas-fir on lower elevation slopes. The mid-elevation zone is forested, dominated by Lodgepole pine, Douglas-fir, and Engelmann spruce. Higher elevations are dominated by Whitebark pine, subalpine fir, alpine grasslands, rocks, and scree. The Buckeye Mine site would be included in the lower elevation slopes.

The presence of Europeans has affected wildlife species and their habitat (USFS, 2001). Europeans initiated mining, timber harvest, grazing, road building and fire suppression. This led to an age class distribution of plant communities across the landscape that is generally older than would have existed before European influence. Indicator wildlife species in the Tobacco Root Mountains include: elk for big game species, sage grouse for sagebrush communities, pine marten for old growth spruce-fir, goshawk for old growth Douglas-fir and trumpeter swan for marshland communities. Threatened and endangered species that can be found on the Madison District of the Beaverhead-Deerlodge National Forest are the threatened grizzly bear and bald eagle (proposed for delisting), nonessential experimental gray wolf, threatened Canada lynx, and proposed threatened mountain plover. Currently in the Tobacco Root Mountains, there are no bald eagle nests, no mountain plovers, and only occasional sightings of grizzly bears, gray wolves, and lynx (USFS, 2001). Sensitive species that are known to occur in the Tobacco Root Mountains are the wolverine, northern goshawk, and black-backed woodpecker. The Tobacco Root Mountains provide habitat for mule deer, whitetail deer, antelope, elk, moose, mountain goat, black bear, and mountain lion (USFS, 2001).

The Montana Department of Fish, Wildlife and Parks (MDFWP) fisheries information contained in the Montana Fisheries Information System (MFISH) database (MDFWP, 2004) indicates that Mill Creek is 20.2 miles long and has the following Fisheries Resource Values (FRV):

	Fisheries Resource Values		
River Miles	Habitat Class	Sport Class	Final Value
0.0 to 1.0	4	3	Substantial
1.0 to 18.5	6	5	Limited

According to the MFISH database, Brook Trout are year-round residents and are considered common in abundance from river miles 0 to 1.0. Rainbow Trout are year-round residents and are considered rare in abundance from river miles 0 to 1.0. Based on the data quality descriptions provided, it appears that no surveys have been completed in the stream area. The data are listed as being based on professional judgment.

The MFISH database lists Mill Creek as a chronic dewatering area of concern from river mile 1.0 to 7.0. MFISH database lists a year-round instream flow protection/quantification flow of 10 cfs from river mile 0.0 to 19.7 (mouth to Branham Lake outlet). Instream flow rights and reservations are provided by Murphy Rights (passed 1969, Section 89-801 (2), RCM 1947) and the Montana Water Use Act (passed 1973, Section 85-2-316, MCA).

2.4.3 Historic or Archaeologically Significant Features

A Cultural Resources Inventory and Assessment was completed for the Buckeye Mine and Mills in November 2003 by Frontier Historical Consultants (Frontier, 2003). The study examined the site to determine: 1) what, if any, cultural resources were in the project area and 2) the significance of the identified resources in terms of the National Register of Historic Places.

One historic site was identified: the Buckeye Mine and Mills site (24MA1314), located at the lower end of Mill Creek Canyon, about three miles upstream from the town of Sheridan in Madison County. The mine site has a headframe, several structures, a historic mill and a modern mill area. Numerous adits and waste rock dumps dating from a century of intermittent mining and milling operations from the 1880s to the 1980s are scattered over the site area. The site includes portions of two mine patents: the Buckeye and Buckeye No. 2; a parcel of BLM land once claimed as the unpatented Lone Tree mining claim; and two tracts of unpatented land at the old community of Brandon, known as the "concentrator lot" and "tailing dump lot."

Natural and man-made forces have seriously eroded the integrity of the Buckeye Mine and Mills site. In addition, recent operations at the site have resulted in the removal, alteration or destruction of several historic structures. The other remaining features are not historically significant. Because of its greatly diminished integrity, the site does not qualify for the National Register of Historic Places as either a mine site or as a historic landscape.

Although the Buckeye Mine was one of the active mining sites in the Sheridan Mining District, albeit a minor one, the site's contribution to the Sheridan Mining District cannot be evaluated. The district's boundaries have not been defined. It has not been inventoried nor has its integrity and significance been assessed. As such the Buckeye Mine and Mills' contribution to a historic Sheridan Mining District cannot be made at this time.

2.4.4 Land Use and Population

Land use in the site area has historically been a mining district. The area does provide some dispersed recreational use for hunters and fishermen. The nearest population to the site area is the town of Brandon, which is located immediately south and west of the site. One residence is located immediately downstream (west) of tailings pile TP-4. There are also several residences directly across Mill Creek Road from the lower portion of the site.

The site is located near the southern end of the Tobacco Root Mountains, which provide many recreational uses. The Tobacco Root Mountains are surrounded by the Madison, Jefferson, and Ruby Valleys. Land in the valleys is privately owned and generally under agricultural production. The foothills are a mixture of private property and public lands managed by the Bureau of Land Management and State of Montana. Generally, the foothills are managed as native rangelands with scattered conifer forests. Some private property has been, and is likely to continue to be, subdivided for housing developments. Above about 6,500 feet in elevation and extending over 10,000 feet, the mountains are public land, managed by the Beaverhead-Deerlodge National Forest with scattered private in-holdings (USFS, 2001).

The Tobacco Root Mountains are a rugged mountain range with many of the high peaks along the range's backbone reaching above timberline, and they typically contain narrow and deep canyons. There are meadows and other open areas below timberline, but the majority of the area is forested. There are many small streams, several of which provide fishing opportunities, but no large streams. Mountain lakes and reservoirs are numerous and most are currently accessible by motorized vehicles of some type.

The Tobacco Root Mountains provide a wide variety of recreation opportunities. Major recreation uses include recreational driving, dispersed and developed site camping, hiking, hunting, fishing, off highway vehicle riding, horseback riding, wildlife viewing, nature study, snowmobiling, cross-country skiing, picnicking, fire wood gathering and other similar activities (USFS, 2001).

Mining activities have been common in the Tobacco Root area since the 1860's. These activities have resulted in an extensive network of low standard roads in many areas. Many of these roads are still open to either full-sized or trail vehicles and driving these roads is one of the common recreation activities in the area. Summer activities constitute the bulk of the recreation activities in the area as a whole, but the period of the most concentrated use is the first two weeks of the general big game hunting season. Winter recreational activities, such as snowmobiling and cross-country skiing, have been well established for many years. There are many miles of groomed and marked snowmobile trails and many more miles of other routes regularly used by snowmobilers and skiers (USFS, 2001).

2.5 PREVIOUS WORK

The only previous available sampling in the Buckeye Mine site was completed by Pioneer Technical Services, Inc. during a Hazardous Material Site inventory for the Montana Department of State Lands, Abandoned Mine Reclamation Bureau (MDSL/AMRB, 1993). This work focused only on the Buckeye Mine which at the time consisted of the millsite area, tailings piles TP1, TP2 and TP3, and waste rock piles WR1, WR2, WR3, WR4 and WR5 only. No work was conducted on tailings piles TP-4 and TP-5 south of Mill Creek road or the Brandon Mill site area.

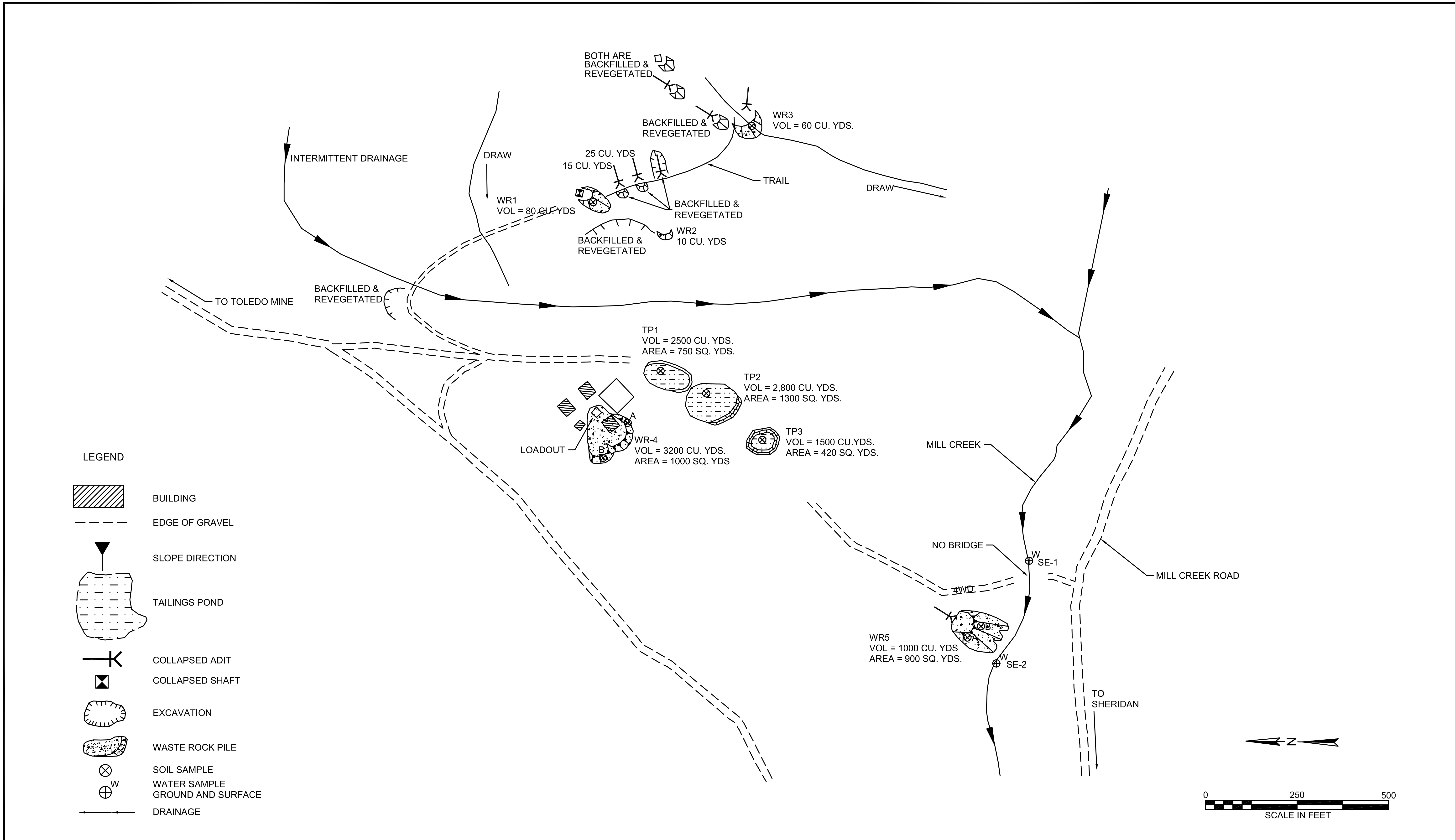
Sampling was conducted by Pioneer Technical Services, Inc, (Pioneer) at the site in August 1993 during the MDSL/AMRB Hazardous Materials Inventory. Fourteen tailings and seven waste rock samples were collected for XRF field screening and two tailings and two waste rock composite samples were prepared from the tailings and waste rock subsamples. Sample locations from the 1993 sample event are shown on Figure 2-4. The XRF field screening and pH results from these samples are summarized in Table 2-2. The Buckeye Mine tailings XRF concentration range results for the principal elements of interest are as follows: silver (Ag; no detection – 92.5 ppm), arsenic (As; no detection – 87.5 ppm), cadmium (Cd; no detection – 146.2 ppm), copper (Cu; no detection – 648.2 ppm), iron (Fe; 22,071 – 53,328 ppm), mercury (Hg; no detection), lead (Pb; no detection - 2,789.3 ppm), manganese (Mn; 396.6 - 2,849.6 ppm), molybdenum (Mo; no detection – 18.9 ppm) and zinc (Zn; 111.4 - 2,773 ppm). The range of pH and radioactivity for the tailings piles are 4.6 to 6.8 standard units (S.U.) and 0.02 to 0.04 milli-roentgens per hour (mR/Hr.), respectively.

The quantitative analytical results for the tailings composite samples are summarized in Table 2-3. The mean concentration and mean concentrations relative to background concentrations for analytes with greater than 50 percent of the tailings samples reporting above the method detection limit are as follows: As 74.2 mg/Kg (4.6x), Cd 6.8 (8.5x), Cu 170 mg/Kg (7.9x), Fe 25,450 mg/Kg (1.7x), Hg 0.58 mg/Kg (0.52x), Mn 1,019 mg/Kg (2.8x), Pb 695.5 mg/Kg (19.3x), and Zn 748.5 mg/Kg (9.4x). Total cyanide was <0.28 ppm. The range of significantly elevated metal concentrations greater than 3 times background soil concentration in the tailings are as follows: As (58.1 – 90.3 mg/Kg), Cd (5.7 – 7.9 mg/Kg), Cu (135 – 205 mg/Kg), Pb (677 – 714 mg/Kg) and Zn (674 – 823 mg/Kg).

Five waste rock piles, WR1 through WR5, were identified during the preliminary assessment. Seven samples were collected for XRF field screening and two representative composite samples were prepared for quantitative laboratory analysis. The XRF field screening and pH results from these samples are summarized in Table 2-2. The Buckeye Mine waste rock XRF concentration range results for the principal elements of interest are as follows: Ag (no detection – 110.2 ppm), As (no detection – 283.3 ppm), Cd (no detection), Cu (no detection – 1,829.8 ppm), Fe (39,243.5 – 96,987.8 ppm), Hg (no detection), Pb (202.1 – 4,084.8 ppm), Mn (no detection – 17,124.4 ppm), Mo (no detection – 8.0 ppm) and Zn (857.7 – 7,395.5 ppm). The range of pH and radioactivity for the waste rock are <3.5 – 6.2 S.U. and 0.0.03 – 0.05 mR/Hr., respectively.

The quantitative analytical results for the two waste rock sample are summarized in Table 2-3. The mean concentration and mean concentrations relative to background concentrations for analytes with greater than 50 percent of the waste rock samples reporting above the method detection limit are as follows: As 244 mg/Kg (15.2x), Cd 21.1 (26.4x), Cu 809.5 mg/Kg (37.5x), Fe 51,900 mg/Kg (3.5x), Hg 1.77 mg/Kg (1.6x), Mn 1,693 mg/Kg (4.6x), Pb 5,363.5 mg/Kg (149x), Sb 9.6 mg/Kg (>2.4x), and Zn 3,595 mg/Kg (44.9x). Total cyanide was not analyzed. The results indicate that As, Cd, Cu, Fe, Mn, Pb, and Zn are significantly elevated (greater than 3 times background soil concentrations) in the waste rock piles.

Olympus field observations indicate that the mill tailings in the Buckeye Mine project area show variable iron oxide staining in the near surface zones that may be related to sulfide oxidation (i.e., pyrite) or the mining of oxidized ores. The waste rock piles generally show moderate to



ADAPTED FROM PA# 29-451, PIONEER TECHNICAL SERVICES, INC., 1993

NO.	REVISION DESCRIPTION	BY	DATE	DESIGN:	DRAWN: KSR	CHECKED: CRS	MONTANA DEQ/MINE WASTE CLEANUP BUREAU BUCKEYE MINE MADISON COUNTY, MONTANA	Olympus Technical Services, Inc.	BUCKEYE MINE MAP PA#29-451	FIGURE 2-4
				APPROVED:	DATE: 9/2003	JOB NO: A1372				
				SCALE: AS SHOWN	FILENAME: A1372PA-map.dwg					

TABLE 2-2. SUMMARY OF XRF FIELD SCREENING AND pH RESULTS
FROM THE PIONEER SAMPLING EVENT AT THE BUCKEYE MINE

Investigator: Pioneer - Flammang and TD&H - Pierson
Investigation Date: 08/27/93

Results in ppm except for pH (standard units) and Radioactivity (milli-roentgens/hour)

FIELD ID	pH	Radioactivity	Ag	As	Ba	Ca	Cd	Co	CrHi	CrLO	Cu	Fe	Hg	K
29-451-TP1A-A	6.4	0.02		77.8899 *	249.42	48132.6	146.19 *				274.874	44935.9		22658.2
29-451-TP1A-B	6.4	0.04		76.8271 *	304.674	30019.9					62.1428 *	43472.5		25155.6
29-451-TP1A-C	6.4	0.04	88.4402 *		356.956	38741.8					275.896	37484		19708.9
29-451-TP1A-D	6.6	0.035	84.4195 *		448.448	99040						35014.9		12734.8
29-451-TP1A-E	6.4	0.03		43.0901 *	396.291	66070.4						37284.3		7306.4
29-451-TP1A-F	6.8	0.04			641.592	88076.7						53328.1		14148.3
29-451-TP2A-A	6.5	0.025			493.829	55898.8						22294.7		16093.6
29-451-TP2A-B	5.9	0.025			472.194	61554.2						22071.1		15563.9
29-451-TP2A-C	5.25	0.035	90.5006 *		458.611	116548					226.686 *	48267.1		12776.8
29-451-TP3A-A	5.6	0.035			151.712	5846.31					648.248	35694		19915
29-451-TP3A-B	6.1	0.03	92.517 *		325.23	8255.47			504.056 *	192.012 *		42395.9		46895
29-451-TP3A-C	6.1	0.03		87.4673 *	224.091	28895.2	139.94 *					35234.6		26747.1
29-451-TP3A-D	6.0	0.035			438.63	52827.4						26894.9		17806
29-451-TP3A-E	4.6	0.035			463.689	73948.4						33594.9		14863.1
29-451-TP-1-COMP					299.502	33287					106.432 *	32658.3		17027.1
29-451-TP-2-COMP					358.05	59085.2					73.6431 *	34733.8		13288.2
29-451-WR4-A	<3.5	0.05	83.1495 *		86.9912	17800.6					572.057	39243.5		17076.5
29-451-WR4-B	<3.5	0.04			198.037	53564.6					810.812	52972.3		16661.3
29-451-WR5-A	5.2	0.04	96.2625 *	230.077 *	278.092	35874.1					368.574	45171.1		28594.2
29-451-WR5-B	<3.5	0.03	106.627 *		98.6169	12928.2			364.741 *		1829.84	58968.8		24918.3
29-451-WR-1	5.4	0.04	110.246 *	278.483 *	225.773	26966					71.2886 *	62953.2		28134.2
29-451-WR-1-COMP				232.529 *	257.089	42710.1						65906.9		23229
29-451-WR-2	4.4	0.03		95.4024 *	291.674	73165						49066.1		11673.3
29-451-WR-2-COMP					164.161	26861.4					969.436	47367.5		17018.9
29-451-WR-3	6.2	0.04		283.311	165.228	32509.3						96987.8		23115.7

FIELD ID	Mn	Mo	Pb	Rb	Sb	Sr	Th	Ti	U	Zn	Zr
29-451-TP1A-A	2392.54		243.822	118.326		54.5042		3651.42		381.106	188.325
29-451-TP1A-B	1549.22		431.532	116.533		71.297		3579.16		1050.26	175.271
29-451-TP1A-C	1264.65 *	7.3193 *	2310.84	92.0423		262.464	22.2634 *	2708.32		2773.49	186.095
29-451-TP1A-D	554.31 *		870.079	66.4682		586.253	14.8072 *	2680.93		446.423	197.417
29-451-TP1A-E	683.304 *		81.393	48.5513		588.647	11.6994 *	2053.53		309.694	142.567
29-451-TP1A-F	1136.67 *		106.014	56.9228		1026.52	8.02375 *	5080.47		283.655	91.413
29-451-TP2A-A	489.296 *			66.0712		289.669	15.6282 *	2018.48		60.5602 *	349.81
29-451-TP2A-B	396.59 *	6.0876 *	18.7892 *	80.1595		329.848	12.9821 *	2031.12		111.362 *	316.173
29-451-TP2A-C	2849.63	15.1586 *	1760.98	104.661		289.444	14.7832 *	1615.19		1410.62	147.772
29-451-TP3A-A	419.541 *	18.9453 *	2789.31	129.374		63.0462	25.0017 *	1357.97		453.908	136.285
29-451-TP3A-B	577.255 *		269.251	191.608		84.7902	8.2832 *	5827.64		549.251	110.969
29-451-TP3A-C	2246.88	5.65163 *	388.197	106.222		48.5812	10.61 *	3365.31		1180.14	154.382
29-451-TP3A-D	679.793 *		106.325	92.2095		310.559	16.2523 *	2363.27		185.487	340.419
29-451-TP3A-E	713.677 *		280.202	60.7106		564.294	8.64222 *	2603.97		432.813	169.519
29-451-TP-1-COMP	1335.14		557.06	86.7407		146.685	10.9035 *	2266.61		629.575	214.939
29-451-TP-2-COMP	874.044 *		608.056	77.7422		400.926	9.53312 *	2488.81		718.4	210.84
29-451-WR4-A			4084.78	64.5284	199.445	340.66		1518.57		1178.82	62.0308
29-451-WR4-B		5.28783 *	2098.68	94.2641		311.794		1755.13		2593.68	145.361
29-451-WR5-A	1355.87 *		1186.14	130.257		232.42		3514.13		7395.49	90.2327
29-451-WR5-B			8370.4	95.4244		114.155	32.3683 *	744.963		857.715	79.4719
29-451-WR-1	3223.11		737.099	139.264		43.4958		4675.52		6574.1	157.698
29-451-WR-1-COMP	5746.27		363.135	131.494		94.2668		2847.79		2950.68	207.225
29-451-WR-2	1966.8		310.039	95.0141		222.482		2606.14		1449.67	189.77
29-451-WR-2-COMP			3995.05	86.3449	56.6008 *	219.652		1083.34		2482.64	71.879
29-451-WR-3	17124.4	7.98645 *	202.104	143.188		90.1372	7.08595 *	1288.97		876.467	109.9

* - Estimated Quantity
$ - Unvalidated Data

TABLE 2-3. SUMMARY OF LABORATORY ANALYTICAL RESULTS FROM THE PIONEER SAMPLING EVENT AT THE BUCKEYE MINE

Investigator: Pioneer - Flammang and TD&H - Pi
Investigation Date: 08/27/93

SOLID MATRIX ANALYSES

Metals in soils
Results per dry weight basis in mg/Kg

FIELD ID	As	Ba	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Sb	Zn	Cyanide
29-451-SE-1	4.27 U	31.1	0.82 U	4.57	21.5	12.5	8020	0.090 J	158	16.9	6.39	5.64 U	22.2	<0.309
29-451-SE-2	8.47 J	71	1.11 U	12.1	62	40.9	15300	0.174 J	192	40.2	55.5	7.68 U	131	<0.387
29-451-TP-1	90.3 J	101	5.65 J	12.8	24.6	205	25200	0.0517 J	978	35.5	677	6.62 U	674	<0.280
29-451-TP-2	58.1 J	121	7.91 J	15.1	18.8	135	25700	1.1 J	1060	28	714	6.87 U	823	<0.283
29-451-WR-1	359 J	98.4	24.90 J	47.4	41.4	159	58700	0.907 J	3050	127	427	6.8 U	4130	NR
29-451-WR-2	129 J	21.4	17.20 J	6.1	3.92	1460	45100	2.64 J	336	7.06	10300	12.4	3060	NR
BACKGROUND	16	89.4	0.8 JX	9.4	25.1	21.6	14900	1.1	366	19	36	4 UJ	80	NR

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Acid/Base Accounting

FIELD ID	Total Sulfur %	Total Sulfur Acid Base t/1000t	Neutral Potential t/1000t	Sulfur Acid/Base Potential t/1000t	Sulfate Sulfur %	Pyritic Sulfur %	Organic Sulfur %	Pyritic Sulfur Acid/Base t/1000t	Sulfur Acid/Base Potential t/1000t
29-451-TP-1	0.73	22.8	113	90.6	0.32	0.28	0.13	8.75	105
29-451-TP-2	0.8	25	124	99	0.19	0.54	0.07	16.9	107
29-451-WR-1DUP	1.75	54.7	117	62.6	0.31	0.86	0.58	26.9	90.4
29-451-WR-1	1.72	53.7	119	65.6	0.28	0.86	0.58	26.9	92.5
29-451-WR-2	6.22	194	15.3	-179	2.66	1.48	2.08	46.2	-30.9

LEGEND

SE1 - 500 feet upgradient of waste rock dump 5 in Mill Creek.
SE2 - Downgradient (@PPE) of waste rock dump 5 in Mill Creek.
TP1 - Composite of subsamples TPA-A, 1A-B, 2A-A,2A-B, 3A-A.
TP2 - Composite of subsamples TP1A-C through 1A-F, TP2A-C. and TP3A-B through 3A-E.
WR1 - Composite of subsamples WR1, 2, and 3.
WR1DUP - Duplicate of sample 29-451-WR-1.
WR2 - Composite of subsamples WR4A, 4B, 5A, and 5B.
BACKGROUND - From Latest Out (29-354-SS-1).

intense iron oxide alteration. Waste rock piles WR4 and WR5 are the most intensely oxidized and characteristically exhibit a sulfur odor typical of strongly oxidizing sulfide-bearing wastes.

Two mill tailings and two waste rock composite samples were analyzed for acid-base accounting during the preliminary assessment of the site. The analytical results are summarized in Table 2-2. The mill tailings showed low total sulfur contents ranging from 0.73 to 0.8 percent (%). The waste rock pile samples showed variable total sulfur content ranging from 1.72% to 6.22% total sulfur. In general, mine/mill wastes containing at least 0.16% total sulfur are susceptible to generating acid rock drainage depending on the inherent neutralization potential of the waste. All of the mill tailings samples showed positive net ABA ranging from +105 to +107 tons $CaCO_3$ equivalent per 1000 tons of waste material (t/1000t).

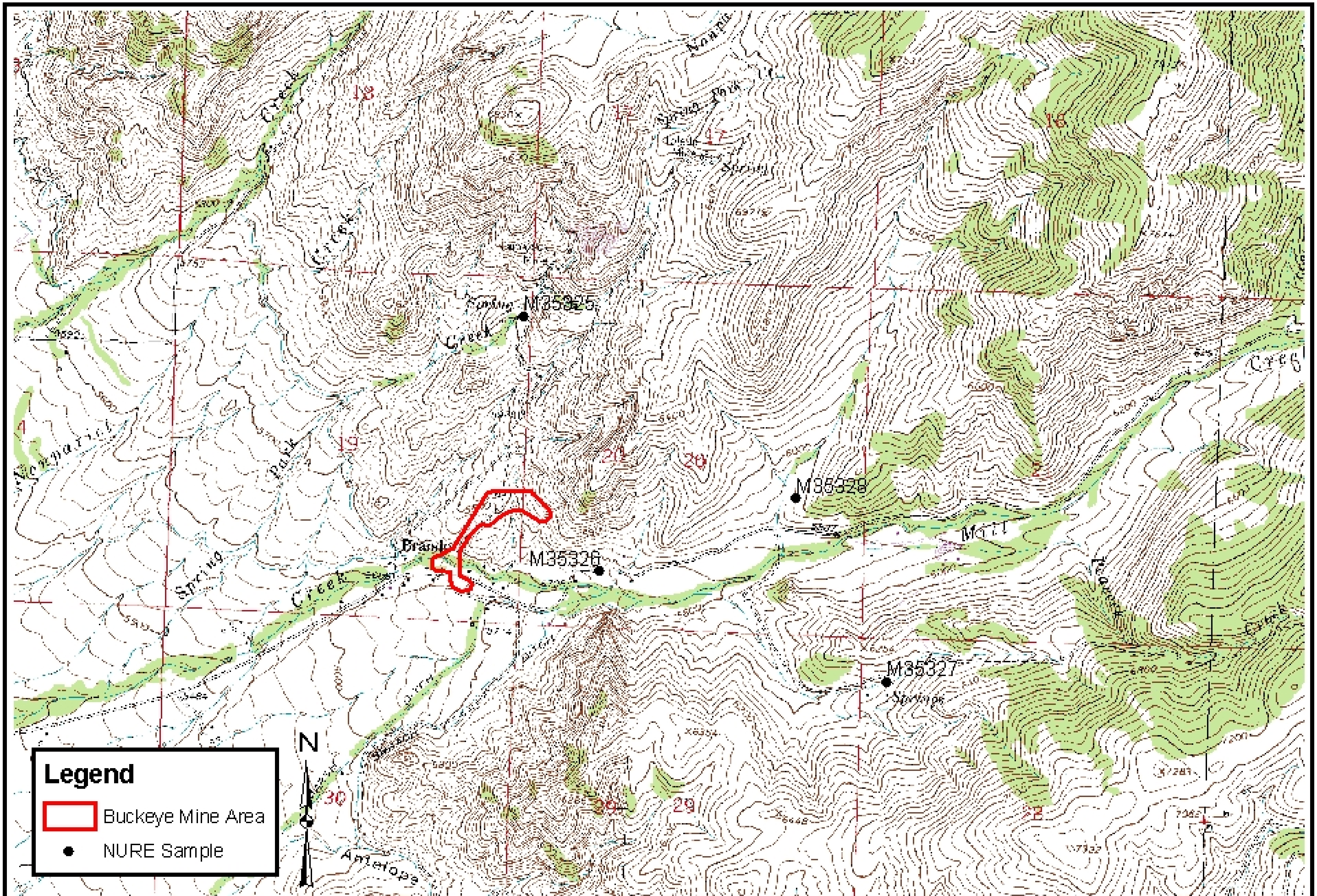
The two composite waste rock samples showed contrasting ABA results ranging from -30.9 to +92.5 t/1000t. The negative ABA result was generated from the composite sample collected from waste rock piles WR-4 and WR-5. This result is consistent with field observations of strong oxidation in these two waste rock piles and indicates that these waste rock piles are sources of acid generation.

The inherent neutralization potential of the waste rock from WR-1, WR-2 and WR-3 is further corroborated by the XRF result for calcium that showed a concentration of 4.3% (10.7% $CaCO_3$). The composite sample collected from waste rock piles WR-4 and WR-5 contains lesser calcium concentration at 2.7% (6.7% $CaCO_3$) to neutralize the significantly higher total sulfur concentration of 6.2% verses 1.7% sulfur present in WR-1 composite. The mill tailings composite samples contained XRF calcium concentrations that ranged from 3.3% to 5.9% (8.3% to 14.8% $CaCO_3$), indicating available inherent neutralization capability.

Mill Creek is the only perennial stream that flows through the Buckeye Mine area. Waste rock pile WR-5 and tailings pile TP-4 are located in close proximity to the stream on the north and south sides, respectively. No surface water samples were collected during the preliminary assessment work in 1993. Two stream sediment samples were collected, one upstream (29-451-SE-1) and one downstream (29-451-SE-2) of the Buckeye Mine waste rock and tailings piles. The sample locations are presented on Figure 2-4 and the laboratory analytical results are summarized in Table 2-3.

No metal/metalloid in the stream sediments is greater than three times the background soil. The only metal/metalloid elements that show an increase in concentration from the upstream to the downstream site relative to the Buckeye Mine area are As (2.0x), Cu (3.3x), Pb (8.7x), and Zn (5.9x). The data suggest that metal/metalloid loading from the tailings pile and/or waste rock pile may be occurring for these elements to the stream base load during stormwater/snowmelt runoff events.

Four stream sediment samples were collected in 1976 in the general area of the Buckeye Mine site as part of the National Uranium Resource Evaluation (NURE) program (USGS, 2001). These samples were collected from tributaries of Mill Creek. The location of the stream sediment samples is presented in Figure 2-5 and the analytical results are summarized in Table 2-4. Although none of the stream sediment samples were collected in the tributary drainage where the Buckeye Mine site is located, the samples are representative of the stream sediment geochemistry for tributaries draining areas upgradient of the site. The range of concentrations reported for the elements of interest are as follows: Ag (<5 ppm), As (not analyzed), Ba (<264-539 ppm), Cd (<5-5 ppm), Co (9.8-27.3 ppm), Cr (68-87 ppm), Cu (18-63 ppm), Fe (13,560-



Olympus Technical Services, Inc.

Figure 2-5
NURE Stream Sediment
Sample Location Map

Table 2-4. BUCKEYE MINE AREA NURE STREAM SEDIMENT GEOCHEMISTRY SAMPLE RESULTS
(Concentrations in ppm)

LASL ID	Lat	Long	Sediment Sample Type	Sample Date	Rock Type	Rock Color	Sediment Type	U	Ag	Al	As	Au	B	Ba
M35327	45.4639	-112.1106	Wet spring	10/10/76	Metamorphic	brown	sand	3.8	-5	53070		-0.06		539
M35528	45.4714	-112.1164	Dry stream	10/10/76	Sedimentary	brown	sand	4.2	-5	64790		-0.08		412
M35326	45.4681	-112.1278	Wet stream	10/10/76	Metamorphic	brown	sand	3.4	-5	57160		-0.07		494
M35325	45.4786	-112.1328	Wet spring	10/10/76	Metamorphic	brown	sand	3.3	-5	54010		-0.07		-264

LASL ID	Lat	Long	Be	Bi	Br	Ca	Cd	Ce	Cl	Co	Cr	Cs	Cu	Dy
M35327	45.4639	-112.1106	2	-5		11850	-5	69	-75	9.8	75	2.7	18	4
M35528	45.4714	-112.1164	4	-5		33400	5	146	-121	27.3	87	6.1	63	10
M35326	45.4681	-112.1278	2	-5		8005	-5	60	-140	16.0	68	4.0	52	4
M35325	45.4786	-112.1328	2	-5		7317	-5	58	-143	18.4	72	3.9	53	3

LASL ID	Lat	Long	Eu	F	Fe	Hf	Hg	K	La	Li	Lu	Mg	Mn	Mo
M35327	45.4639	-112.1106	1.1		13560	13.9		13100	40	29	0.5	15350	418	
M35528	45.4714	-112.1164	1.8		51570	20.5		13860	66	22	1.4	25700	1710	
M35326	45.4681	-112.1278	1.1		23160	7.1		14610	37	19	0.4	15290	2865	
M35325	45.4786	-112.1328	1.2		23070	6.2		12030	38	25	0.3	12460	2816	

LASL ID	Lat	Long	Na	Nb	Ni	P	Pb	Pt	Rb	Sb	Sc	Se	Sm	Sn	Sr
M35327	45.4639	-112.1106	8867	-20	20		10		34	-2	6.7		4.8	-10	-280
M35528	45.4714	-112.1164	15270	-20	64		-5		55	-3	22.9		9.2	-10	-452
M35326	45.4681	-112.1278	7472	-20	17		26		65	-2	10.6		4.2	-10	-644
M35325	45.4786	-112.1328	7297	-20	32		21		41	-2	10.6		4.2	-10	-670

LASL ID	Lat	Long	Ta	Tb	Th	Ti	V	W	Y	Yb	Zn	Zr	PO_4	NO_3	SO_4
M35327	45.4639	-112.1106	-1	-1	8.7	3260	63	-15		3.5	91				
M35528	45.4714	-112.1164	2	1	15.2	9111	177	-15		11.9	125				
M35326	45.4681	-112.1278	-1	-1	10.3	3109	66	-15		3.5	139				
M35325	45.4786	-112.1328	1	-1	12.8	3838	77	-15		3.4	159				

NURE = National Uranium Resource Evaluation program
LASL = Los Alamos Scientific Laboratory
Blank data = not analyzed; Negative value indicates not detected or less than listed value

51,570 ppm), Hg (not analyzed), Mn (418-2,865 ppm), Ni (17-64 ppm), Pb (<5-26 ppm), Sb (<3 ppm), and Zn (91-159 ppm).

The preliminary assessment indicated that there are no groundwater wells, flowing adits or groundwater springs at the site. Therefore, no groundwater samples were collected during the preliminary assessment of the Buckeye Mine site. At the time, the preliminary assessment only evaluated the Buckeye Mine waste sources north of Mill Creek.

3.0 LAND OWNERSHIP SUMMARY

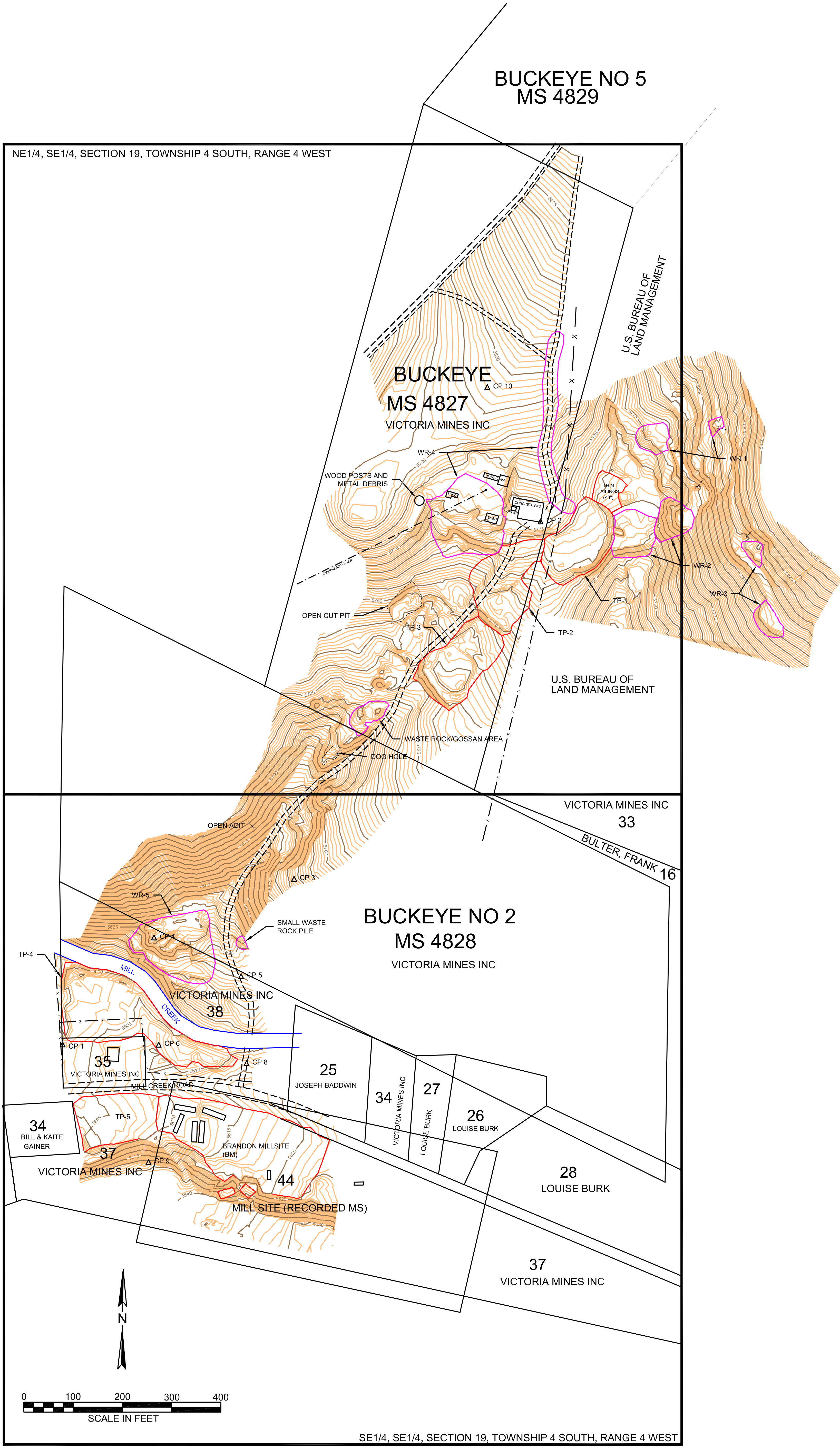
Land ownership in the area of the Buckeye Mine site was compiled by Thompson and Associates in the Fall of 2004. Figure 3-1 shows the location of the parcels and Table 3-1 provides a summary of the land ownership in the area of the Buckeye Mine site waste sources.

4.0 FIELD ACTIVITIES

The objective of the Buckeye Mine site characterization is to collect sufficient data from the site to perform a risk assessment and detailed analysis of reclamation alternatives. The principal techniques used for data acquisition in this site investigation were backhoe test pits, shovel test pits, hand auger test holes, field mapping, soil, stream sediment, surface water and groundwater sampling. Samples were collected using standard operating procedures that are contained in the Field Sampling Plan (DEQ-MWCB/Olympus, 2004a) and were analyzed according to the Laboratory Analytical Plan (DEQ-MWCB/Olympus, 2004c). Analytical data were evaluated for quality assurance according to the Quality Assurance Project Plan (DEQ-MWCB/Olympus, 2004d).

Site characterization field activities were conducted during the period July 26, 2004 through July 30, 2004. Site characterization activities focused on:

- Background soil characterization;
- Mill tailings characterization (mapping, volume estimate, geology, metals/pH chemistry, acid-base accounting and toxicity characteristic leaching procedure (TCLP));
- Waste rock characterization (mapping, volume estimate, geology, metals/pH chemistry, acid-base accounting and TCLP);
- Surface water characterization (water quality and flow rate);
- Groundwater characterization (shallow private wells and spring);
- Assessment of airborne particulate emissions;
- Assessment of physical hazards;
- Summary of contaminant exposure pathways;
- Potential repository site investigation; and



Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU BUCKEYE MINE SITE MADISON COUNTY, MONTANA	BUCKEYE MINE SITE LAND OWNERSHIP MAP	FIGURE 3-1

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TABLE 3-1 SUMMARY OF BUCKEYE MINE SITE LAND OWNERSHIP

Parcel	Owner Name
Buckeye MS# 4827 and Buckeye No. 2 MS# 4828, located in Section 19, Township 4 South and Range 4 West	Victoria Mines, Inc. c/o John Naisbitt, 1028 2nd Ave., Kalispell, MT 59901
#35, #37, and #38, located in Section 19, Township 4 South and Range 4 West	Victoria Mines, Inc. c/o John Naisbitt, 1028 2nd Ave., Kalispell, MT 59901
#44 Mill Site (Recorded MS) located in Section 19, Township 4 South, Range 4 West	Ownership not clear but believed to be Victoria Mines, Inc. c/o John Naisbitt, 1028 2nd Ave., Kalispell, MT 59901
U.S. Bureau of Land Management located in Sections 19 and 20, Township 4 South and Range 4 West	Dillon Field Office, Bureau of Land Management, 1005 Selway Dr., Dillon, MT 59725

- Potential borrow source investigation.

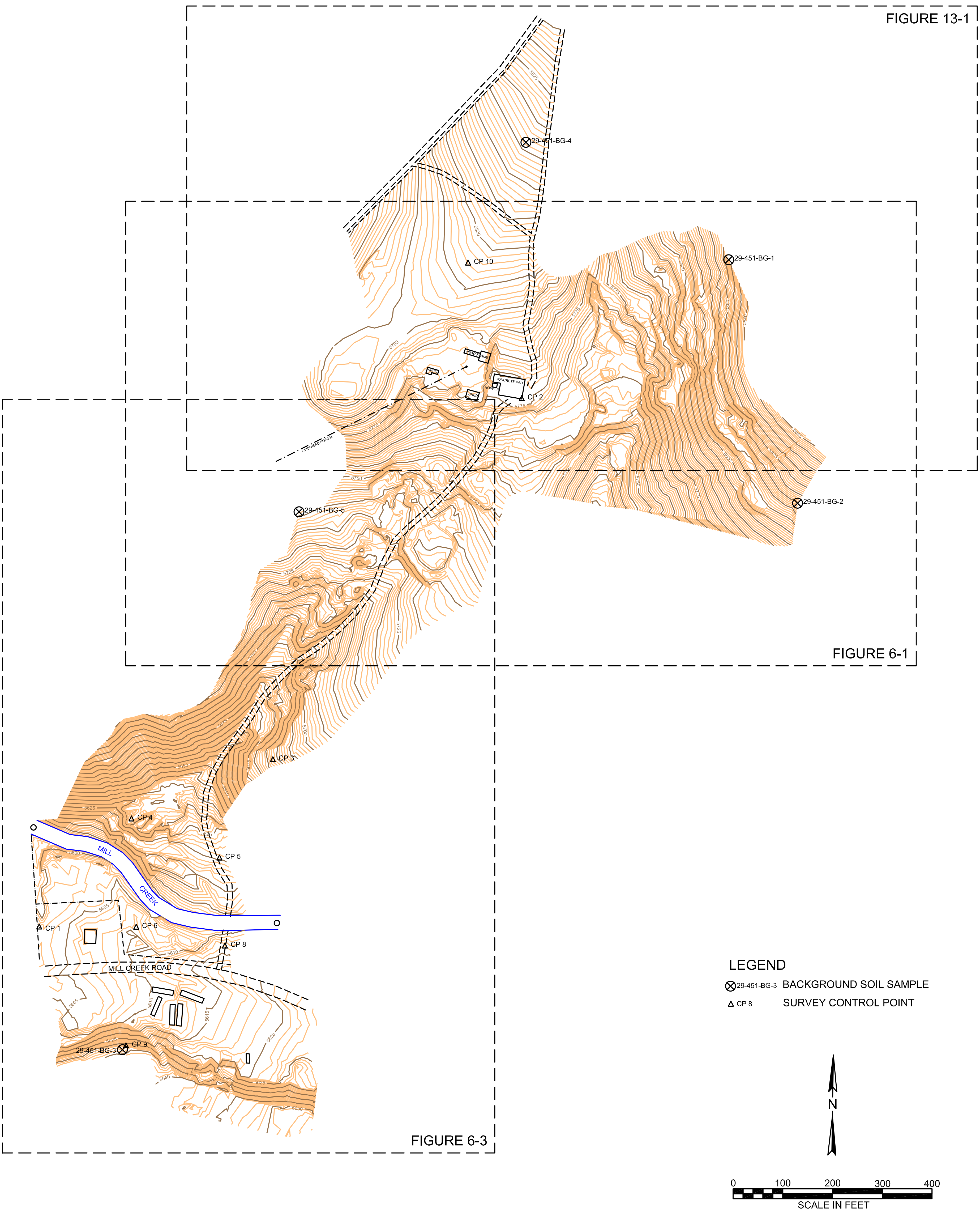
The following sections summarize the results of the site characterization activities.

5.0 BACKGROUND SOIL CHARACTERIZATION

Five background soil samples (29-451-BG1 through 29-451-BG5) were collected in the Buckeye Mine project area. The sample locations are shown on the Buckeye Mine site topographic index map presented in Figure 5-1. The samples were selected to provide representative background soil coverage of the area containing the mine/mill sites. The samples were collected from outside of known waste areas and areas of other disturbances.

Three background soil samples (29-451-BG1 through 29-451-BG3) were screened for a multi-element suite using a portable x-ray fluorescence (XRF) analyzer and the five background soil samples (29-451-BG1 through 29-451-BG5) were analyzed at Energy Laboratories, Inc. for paste pH, silver (Ag), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), mercury (Hg), lead (Pb), manganese (Mn), nickel (Ni), antimony (Sb) and zinc (Zn). The laboratory analytical results are presented in Table 5-1. XRF analytical results are contained in Appendix A and laboratory analytical data and chain-of-custody are contained in Appendix B.

Laboratory measured background soil pH is near neutral and ranges from 7.4 to 7.5 standard units (SU), with a mean of 7.42 SU. Antimony, cadmium, mercury and silver were below detection limits. The following range and mean concentrations were detected in the background soil samples: As ranged from <5 to 15.2 mg/Kg (with a mean of 9.0 mg/Kg), Ba 123 to 173 mg/Kg (152.2 mg/Kg), Cr 18.3 to 49.9 mg/Kg (33.1 mg/Kg), Cu 19.3 to 46.1 mg/Kg (34.4 mg/Kg), Fe 12,800 to 17,600 mg/Kg (15,240 mg/Kg), Mn 274 to 1,000 mg/Kg (492.6 mg/Kg), Ni 16.3 to 31.1 mg/Kg (22.7 mg/Kg), Pb 10.5 to 105 mg/Kg (37.5 mg/Kg) and Zn 36.7 to 157 mg/Kg (78.8 mg/Kg). The background soil sample results generated by previous workers are generally within the range of concentrations determined in this work with the exception of Ba which was slightly lower, and Hg which was detected just above the lower detection limit. Cobalt (Co) was analyzed previously at a concentration of 9.4 mg/Kg.



Olympus Technical Services, Inc.				MONTANA DEQ/MINE WASTE CLEANUP BUREAU BUCKEYE MINE SITE MADISON COUNTY, MONTANA		BUCKEYE MINE SITE TOPOGRAPHIC MAP	FIGURE 5-1
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Table 5-1. Background Soil Chemistry Results

Sample ID	Paste pH	Ag (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Pb (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)
29-451-BG1	7.4	<5	<5	148	<1	41.9	40.5	15100	<1	1000	25.1	10.8	<5	36.7
29-451-BG2	7.5	<5	7.7	158	<1	49.9	36.6	17600	<1	274	23.0	10.5	<5	37.9
29-451-BG3	7.4	<5	12.3	123	<1	33.8	46.1	15000	<1	397	31.1	105	<5	157
29-451-BG4	7.4	<5	7.4	159	<1	21.6	29.5	15700	<1	466	18.1	48.7	<5	123
29-451-BG5	7.4	<5	15.2	173	<1	18.3	19.3	12800	<1	326	16.3	12.5	<5	39.4
Maximum	7.5	<5	15.2	173	<1	49.9	46.1	17600	<1	1000	31.1	105	<5	157
Minimum	7.4	<5	<5	123	<1	18.3	19.3	12800	<1	274	16.3	10.5	<5	36.7
Mean	7.42	2.50	9.0	152.2	0.50	33.1	34.4	15240.0	0.50	492.6	22.7	37.5	2.5	78.8
n	5	5	5	5	5	5	5	5	5	5	5	5	5	5

LEGEND

29-451-BG1 Located approximately 100' up the ridge to the NE from the upper portion of waste rock pile WR1
29-451-BG2 Located approximately 60' to the east of the southern portion of waste rock pile WR3
29-451-BG3 Located approximately 120' to southeast up the ridge from the center of tailings pile TP5 and adjacent to survey control point CP9
29-451-BG4 Located approximately 435' to the NE of the headframe located near waste rock pile WR4
29-451-BG5 Located approximately 220’ to west of tailings pile TP3 up the ridge

Note: Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation
NA = Not analyzed

Pioneer Technical Services, Inc. Background Sample

Sample ID	Paste pH	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Co (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Pb (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)
BACKGROUND		16	89.4	0.8 JX	9.4	25.1	21.6	14,900	1.1	366	19	36	4 UJ	80

U - Not Detected; J - Estimated Quantity; X - Outlier for Accuracy or Precision; NR - Not Requested

Note: BACKGROUND collected from the Latest Out (PA # 29-354-SS-1) area for the Buckeye Mine preliminary assessment

6.0 MINE/MILL WASTE CHARACTERIZATION

6.1 MILL TAILINGS

Five mill tailings areas have been identified and these include: tailings piles TP-1, TP-2, TP-3, TP-4 and TP-5. The tailings piles were investigated using one or more of the following methods: backhoe test pits, hand auger/shovel pits, chemical analysis of samples and field observations. Backhoe test pit and hand auger/shovel pit logs for the mill tailings areas are summarized in Appendix C.

Representative samples of mill tailings were collected by one or more of the following methods: vertical channel samples taken from test pit walls, grab samples collected from test pit excavation stockpiles and samples collected via hand auger or shovel. Individual samples were collected based on similar geologic characteristics. Samples were collected with stainless steel tools using a deionized (DI) water rinse, dilute HNO_3 rinse followed by a final DI rinse. All samples collected during the tailings investigation were analyzed by X-ray fluorescence spectrometry (XRF) for a multi-element suite. A Niton XL-703A portable XRF analyzer was used to provide qualitative to semi-quantitative analyses for a 14-element suite including arsenic (As), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), mercury (Hg), molybdenum (Mo), nickel (Ni), rubidium (Rb), strontium (Sr), zinc (Zn) and zirconium (Zr). The XRF instrument employed a single radioisotope source, Cd-109. Because the Buckeye Mine site orebodies were predominantly lead-zinc and the preliminary assessment data indicted that Pb was the principal contaminant of concern, a single source instrument was deemed suitable for field screening of waste sources at the site. Although cadmium was not monitored during XRF field screening because of using the Cd109 radioisotope source, cadmium concentrations commonly geochemically track zinc concentration. The preliminary assessment laboratory analytical results for zinc and cadmium on tailings and waste rock composite samples had a strong correlation coefficient of 0.992. The final laboratory concentration data results for zinc and cadmium also had strong correlation coefficients for tailings and waste rock at 0.994 and 0.977, respectively (Appendix B). Thus when zinc concentrations increase in waste sources, one can usually expect cadmium concentrations to likewise increase. The XRF analytical results and basic univariate statistics for samples collected in each of the tailings piles are contained in Appendix A.

Tailings piles are generally created by depositing sediment slurry into a basin setting. Thus tailings piles commonly exhibit a stratigraphy that is similar to undisturbed sedimentary rocks with vertical layering and lateral facies changes. Chemical changes in the pile are directly related to changes in the chemistry of the orebody and/or changes in the metallurgical processing method. All of the tailings piles located in the Buckeye Mine site are relatively small facilities occupying areas ranging from 0.36 to 0.77 acres. Tailings pile TP-4 is the largest individual tailings area. The tailings were generated from two mill site areas. The tailings piles TP-1 through TP-3 are associated with a former early 1980's small mill operation (reportedly 50-ton flotation) located on the Buckeye claim at the northern extent of the Buckeye Mine site (Frontier Historical Consultants, 2003). Much of the tailings piles TP-4 and TP-5 were most likely generated from the Brandon Mill operation (reportedly 125-ton flotation) in late 1920's and this mill was located at the southern extent of the Buckeye Mine site on the south side of the Mill Creek Road. The Brandon Mill site reportedly was the site of at least three mills which were constructed and/or modified during the years 1865, 1890 and 1929 (Frontier Historical Consultants, 2003).

To evaluate the chemistry of the tailings piles, representative composite samples were collected in order to control the number of samples submitted for quantitative laboratory analyses. Composite samples of the tailings were made from two or more test pits or hand auger/shovel intervals based on the evaluation of the geology of the pile and XRF sample results. Composite samples collected from the tailings piles were analyzed at Energy Laboratories, Inc. in Helena, MT for the following target analyte list: pH, Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb, Zn and total cyanide. The analytical methods are summarized in the Field Sampling Plan (MDEQ-MWCB/Olympus, 2004a). The tailings analytical chemistry results are summarized in Table 6-1 and the laboratory data sheets and chain-of-custody forms are contained in Appendix B. A comparison of mill tailings qualitative to semi-quantitative XRF and quantitative laboratory analytical results was made for lead and zinc. The comparative results (Appendix B) indicate that lead and zinc data sets show statistically significant correlation coefficients of 0.930 and 0.982, respectively.

The following sections describe results of investigations pertaining to volume estimates, geology, pH/metals chemistry, acid-base accounting and hazardous waste characterization for the Buckeye Mine tailings located in the Mill Creek drainage.

6.1.1 Tailings Pile TP-1

The tailings pile TP-1 is located in the E½, SE¼ Section 19, Township 4 South and Range 4 West, Montana Principal Meridian (Figure 1-1). The tailings pile is a small side hill tailings deposit adjacent to the north-south ephemeral tributary of Mill Creek. The tailings were generated from the former millsite located in the area of the concrete pad to the northwest. Vegetation in the tailings pile TP-1 area is very sparse on top of the pile. The side slopes of the tailings pile are moderately well vegetated and this probably indicates some native soil material is present in the starter berm for the side hill deposit. The exposed tailings exhibit variable iron oxidation (FeOx) evidenced by orange brown coloration.

6.1.1.1 Tailings Pile TP-1 Volume Estimate

The TP-1 tailings volume was estimated using the detailed topographic survey of the tailings surface and the backhoe test pit data (Figure 6-1). The test pit data were used to evaluate the depth of the tailings and the elevation of the native surface. The native surface elevations were plotted and the native surface below the tailings was reconstructed into a surface model that fit the test pit data and topography surrounding the tailings (Figure 6-2). Eagle Point Civil/Survey 2002 software was used to triangulate and contour the native surface model. The contoured native surface was then evaluated to ensure that it was a reasonable representation of what the pre-tailings deposition surface may have looked like.

Eagle Point calculates volumes using a prismoidal method. The prismoidal method uses a form of finite element analysis and is a true volume calculation, rather than an averaging method. The method forms a series of prisms between two surfaces (such as the existing tailings surface and the projected native surface) and calculates the volume of each prism. The total volume is calculated by summing the volume of the individual prisms.

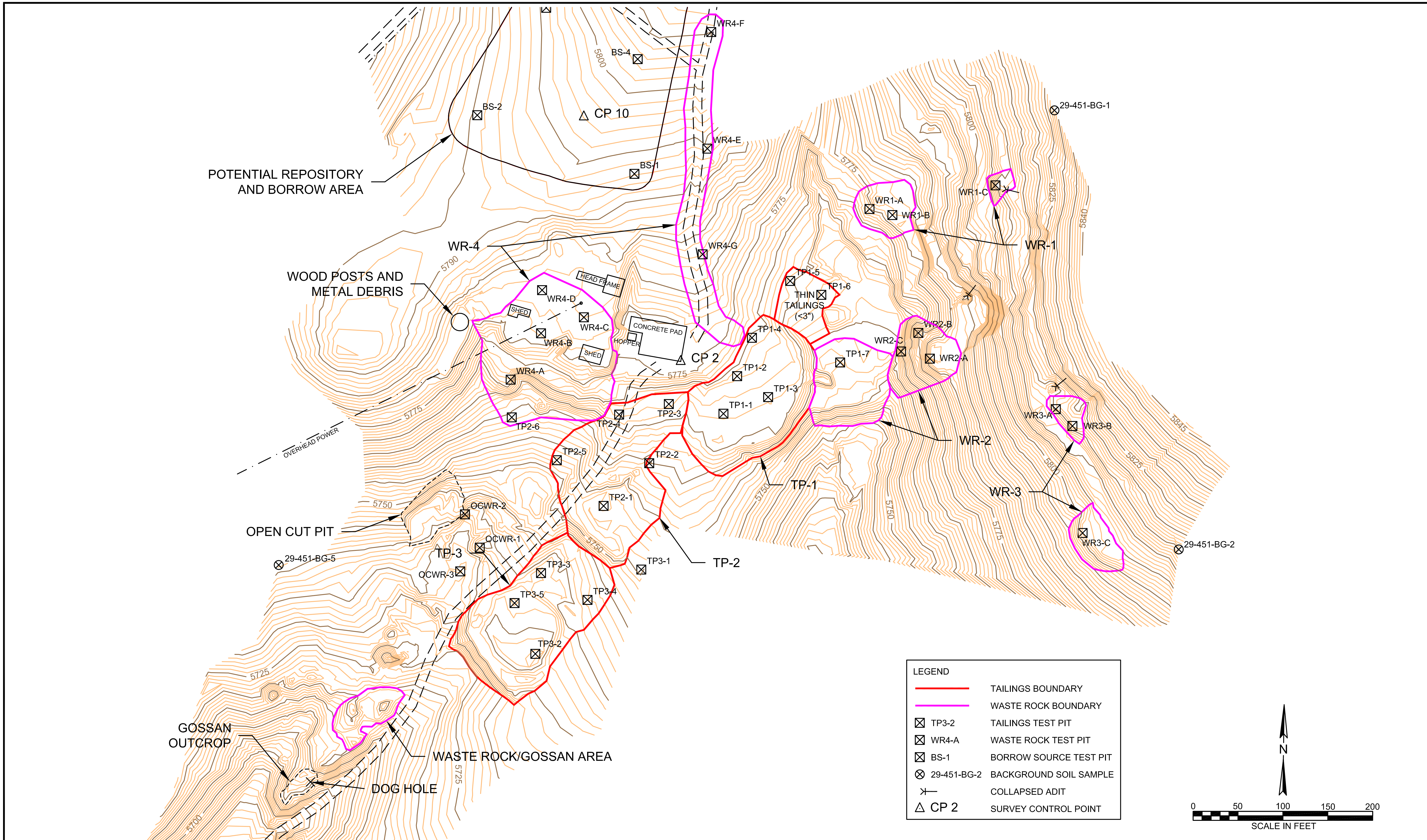
TABLE 6-1. Laboratory Chemistry Results For Mill Tailings

Sample ID	pH (SU)	Ag (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Pb (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)	Total Cyanide (mg/Kg)	Comments
Tailings Pile TP1																
29-451-TP1-1	7.0	15.4	99.8	76.0	9.7	12.4	522	34100	<1	605	18.9	1990	13.4	1920	<0.5	Composite of TP1-1-0-2.8; TP1-3-0-1.6; TP1-2-0-1.7
29-451-TP1-2	7.2	7.2	206	62.2	9.2	40.6	129	33200	<1	1230	44.9	892	<5	1760	<0.5	Composite of TP1-1-2.8-5.4; TP1-3-4.2-5.8
29-451-TP1-3	7.8	<5	45.1	167	2.9	23.6	94.1	24200	<1	714	25.0	281	<5	494	<0.5	Composite of TP1-2-3.7-8.0; TP1-1-5.4-9.6; TP1-3-5.8-12.9; TP1-4-3.5-8.3
29-451-TP6-1	5.3	6.1	175	54.4	8.9	36.9	172	33000	<1	1000	42.8	1140	<5	1530	<0.5	Duplicate sample of 29-451-TP1-1
Maximum	7.8	15.4	206	167	9.7	40.6	522	34100	<1	1230	44.9	1990	13.4	1920	<0.5	
Minimum	5.3	6.1	45.1	54.4	2.9	12.4	94.1	24200	<1	605	18.9	281	<5	494	<0.5	
Mean	6.83	7.80	131.48	89.90	7.68	28.38	229.28	31125.0		887.3	32.90	1075.8		1426.0		
No. Samples	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	
Tailings Pile TP2																
29-451-TP2-1	7.9	<5	9.7	182	1.6	16.4	62.4	16000	<1	423	14.8	109	<5	394	<0.5	Composite of TP2-4-0-2.1; TP2-1-2.2-3.9
29-451-TP2-2	7.9	<5	6.5	178	1.4	17.6	54.4	15200	<1	383	15.2	97.0	<5	328	<0.5	Composite of TP2-2-0-5; TP2-3-0.6-4.6; TP2-5-0-4.8; TP2-6-2.1-4.9
Maximum	7.9	<5	9.7	182	1.6	17.6	62.4	16000	<1	423	15.2	109	<5	394	<0.5	
Minimum	7.9	<5	6.5	178	1.4	16.4	54.4	15200	<1	383	14.8	97.0	<5	328	<0.5	
Mean	7.90		8.10	180.0	1.50	17.00	58.40	15600.0		403.0	15.00	103.00		361.0		
No. Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	
Tailings Pile TP3																
29-451-TP3-1	8.0	<5	5.6	181	1.1	18.8	40.2	15000	<1	396	17.0	86.5	<5	189	<0.5	Composite of TP3-3-0-4.8; TP3-4-0-5.9; TP3-1-0-5.5
29-451-TP3-2	7.5	59.7	508	21.6	6.9	12.6	1430	51100	<1	351	8.5	5510	<5	324	<0.5	Composite of TP3-2-0-1.8; TP3-2-1.8-4.9
29-451-TP3-3	7.9	<5	18.5	131	2.4	21.2	44.7	18800	<1	639	34.7	118	<5	412	<0.5	Composite of TP3-2-4.9-8.8; TP3-5-5.4-10.2
Maximum	8.0	59.7	508	181	6.9	21.2	1430	51100	<1	639	34.7	5510	<5	412	<0.5	
Minimum	7.5	<5	5.6	21.6	1.1	12.6	40.2	15000	<1	351	8.5	86.5	<5	189	<0.5	
Mean	7.80		177.37	111.20	3.47	17.53	504.97	28300.0		462.0	20.07	1904.83		308.3		
No. Samples	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Tailings Pile TP4																
29-451-TP4-1	5.9	21.9	143	51.2	23.1	6.6	472	23500	2.3	478	13.4	2540	11.5	3500	<0.5	Composite of TP4-1-0-3.1; TP4-2-0-2.0; TP4-7-0-1.9
29-451-TP4-2	6.0	60.1	189	48.3	79.3	<5	1980	38100	3.3	575	14.5	7750	49.9	12500	<0.5	Composite of TP4-2-2.0-2.6; TP4-4-3.7-5.0; TP4-11-2.5-3.1
29-451-TP4-3	7.4	15.5	338	32.3	48.2	19.2	560	25200	<1	1310	34.1	1640	13.6	6650	<0.5	Composite of TP4-3-0-2.5; TP4-5-0-2.5; TP4-6-0-3.2
Maximum	7.4	60.1	338	51.2	79.3	19.2	1980	38100	3.3	1310	34.1	7750	49.9	12500	<0.5	
Minimum	5.9	15.5	143	32.3	23.1	<5	472	23500	<1	478	13.4	1640	11.5	3500	<0.5	
Mean	6.43	32.50	223.3	43.93	50.20	9.43	1004.0	28933.3	2.03	787.7	20.67	3976.7	25.00	7550.0		
No. Samples	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Tailings Pile TP5																
29-451-TP5-1	4.7	11.8	106	85.7	6.6	29.6	287	23600	<1	290	18.6	1440	<5	1070	<0.5	Composite of TP5-1-0-1.1; TP5-3-0-0.6; TP5-4-0-0.3
29-451-TP5-2	6.1	22.7	222	60.0	15.4	19.6	458	28200	2.5	575	22.4	2900	11.7	2850	<0.5	Composite of TP5-5-0-2.5; BM15-0-1.2
Maximum	6.1	22.7	222	85.7	15.4	29.6	458	28200	2.5	575	22.4	2900	11.7	2850	<0.5	
Minimum	4.7	11.8	106	60.0	6.6	19.6	287	23600	<1	290	18.6	1440	<5	1070	<0.5	
Mean	5.40	17.25	164.0	72.85	11.00	24.60	372.5	25900.0	1.5	432.5	20.50	2170.0	7.1	1960.0		
No. Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

TABLE 6-1. Laboratory Chemistry Results For Mill Tailings

Sample ID	pH (SU)	Ag (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Pb (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)	Total Cyanide (mg/Kg)	Comments
Brandon Mill																
29-451-BM-1	5.2	58.1	367	120	9.0	21.7	692	44900	1.4	220	18.1	11200	12.8	2060	<0.5	Composite of BM1-0-0.5; BM4-0-1.0; BM5-0-0.7
29-451-BM-2	3.7	49.9	295	109	5.0	29.3	505	37400	1.4	135	16.2	7240	13.7	1010	<0.5	Composite of BM7-0-1.1; BM10-0-0.9; BM14-0-0.5
29-451-BM-3	2.1	268	455	53.3	16.8	11.3	961	77000	2.6	45.8	13.4	43400	32.4	2830	<0.5	Composite of BM18; BM19
29-451-BM-4	6.5	57.8	296	115	11.7	23.1	812	48300	<1	274	16.5	11900	13.4	2280	<0.5	Duplicate sample of 29-451-BM-1
Maximum	6.5	268	455	120	16.8	29.3	961	77000	2.6	274	18.1	43400	32.4	2830	<0.5	
Minimum	2.1	49.9	295	53.3	5.0	11.3	505	37400	<1	45.8	13.4	7240	12.8	1010	<0.5	
Mean	4.38	108.45	353.3	99.33	10.63	21.35	742.5	51900.0	1.48	168.70	16.05	18435.0	18.08	2045.0		
No. Samples	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	

Note: Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation



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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
BUCKEYE MINE SITE
MADISON COUNTY, MONTANA

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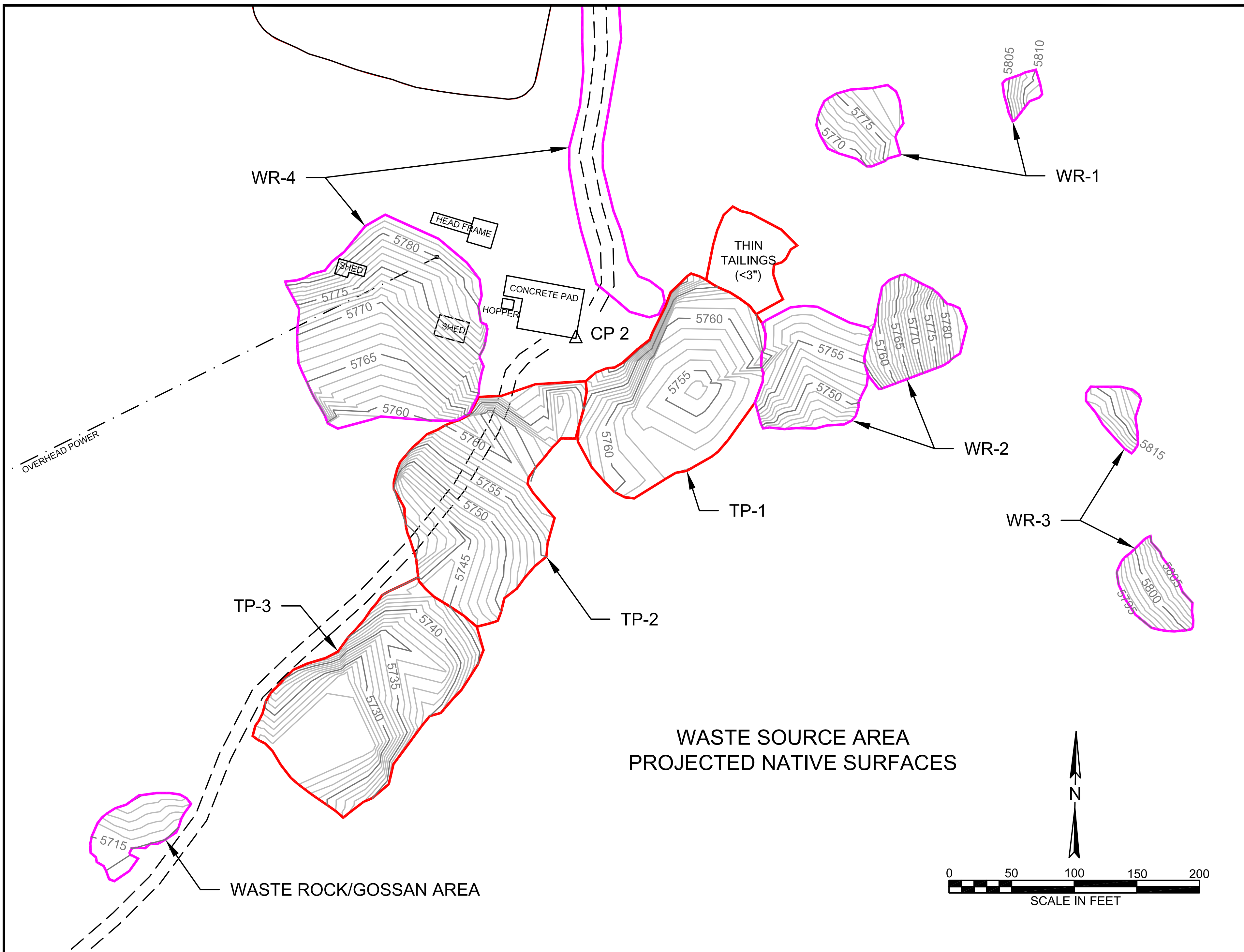
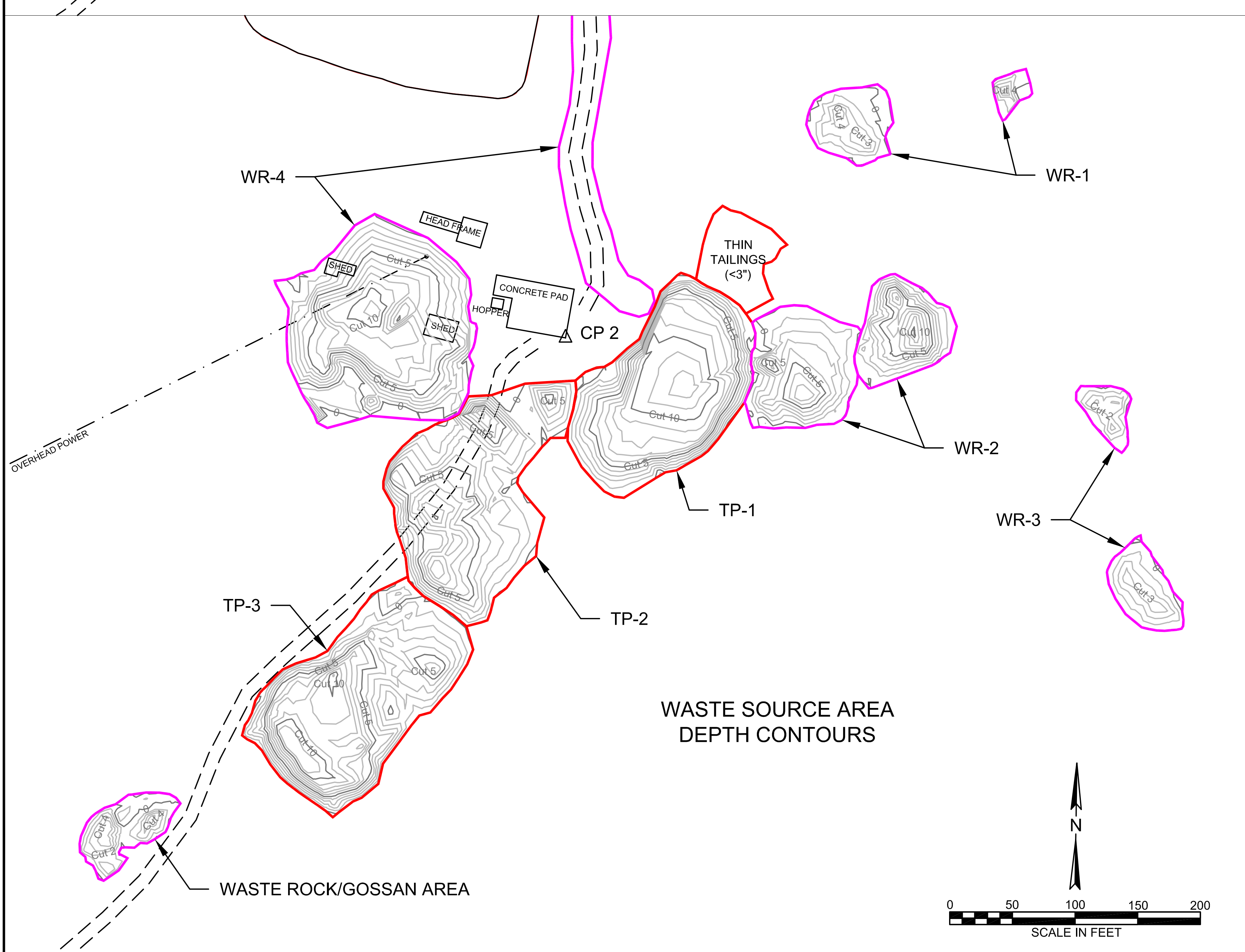
UPPER BUCKEYE MINE SITE AREA

FIGURE 6-1





Olympus Technical Services, Inc.

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
BUCKEYE MINE SITE
MADISON COUNTY, MONTANA

UPPER BUCKEYE MINE AREA
PROJECTED NATIVE SURFACE
AND DEPTH CONTOURS

FIGURE
6-2

DESIGN:	DRAWN: KSR	CHECKED: CRS	APPROVED:	DATE: 12/2004	JOB NO: A1431	SCALE: AS SHOWN	FILENAME: A1431Buckeye.dwg

The estimated volume of the tailings pile TP-1 is 4,000 cubic yards (Table 6-2). There are two areas of tailings, the main pile and a thin (<3 inches thick) tailings veneer to the northeast that resulted from erosion via stormwater/snowmelt runoff. In the main tailings pile the plan area is 0.38 acres and the average tailings depth is 6.4 feet. The maximum tailings thickness measured in the test pits was 12.9 feet. The smaller area of surface tailings deposition occupies 0.09 acre. A total of 6 backhoe test pits were excavated in the tailings pile TP-1 area.

6.1.1.2 Tailings Pile TP-1 Geology

The TP-1 tailings pile geology is based on observations made from 6 test holes (Figure 6-1). Test pit logs are contained in Appendix C. All of the backhoe test pits intercepted native soil. The upper zone of the tailings pile is comprised predominantly of oxidized silty sand with varying degrees of orange to yellow brown iron oxide (FeOx) coloration. The non-oxidized tailings generally consist of light brown to tan silty sand with lesser clayey silt to silty clay layers. The tailings slimes in TP-1 consist of bluish gray silty clay with lesser light green silty clay. Test pits TP1-1 and TP1-3 intersected tailings slime zones less than 3 feet thick. The TP-1 tailings is dry with the exception of slight to moderate moisture detected in the finer-grained slime zones. The native soil horizon below the tailings generally consists of dry coalluvium containing sand, gravel and rock. This material varies from dark gray to black, micaceous-rich sand to tan to light brown sand containing abundant gravel with rock ranging from 4- to 12-inch diameter.

Particle size analyses for selected tailings intervals are summarized in Table 6-3 and contained in Appendix B. The laboratory analyses for representative samples of orange to yellow brown silty sand, light green to bluish gray silty clay and light brown silty sand from TP1 indicate that these tailings are sandy silt with 22% clay, clayey silt, and silty sand with 15% clay, respectively.

6.1.1.3 Tailings Pile TP-1 Metal/pH Chemistry Results

Representative samples were collected from vertical channel samples taken from the test pit wall or from grab samples collected from the test pit excavation stockpile. Individual samples were collected based on similar geologic characteristics. Seventeen tailings samples and three representative composite tailings samples were collected from the TP-1 tailings pile area for XRF screening. In addition, four native soil samples were collected from below the tailings near the contact zone for XRF screening. In addition, a single rock sample (TP1-ORE) was screened via XRF with questionable results, probably related to the fact that the instrument was setup for soil samples and the angularity of the rock sample. The rock sample contained visible pyrite, galena and sphalerite, although the results returned elevated iron only. The XRF results are contained in Appendix A. The TP-1 tailings XRF concentration range results for the principal elements of interest are as follows: As (no detection - 320.8 ppm), Cr (no detection – 3,328 ppm), Cu (no detection - 383 ppm), Fe (17,689.6 - 51,686.4 ppm), Mn (no detection - 2,560 ppm), Mo (no detection - 32.3 ppm), Ni (no detection – 7,174.4 ppm), Pb (116.7 - 2,880 ppm), and Zn (305 - 3,628.8 ppm). Mercury had essentially no detection except for a single sample that had an estimated concentration of 75.4 ppm.

Four native soil samples were collected below the tailings for XRF screening analysis. When compared to background soil and the mean element concentrations for tailings pile TP-1, the results suggest that there is some mobilization of Pb and Zn from the tailings into the native soils.

Table 6-2. Buckeye Mine and Brandon Mill Waste Volume Summary

Source	Volume (CY)	Calculation Method	Plan Area (SF)	Plan Area (AC)	Average Thickness (ft)	Max Thickness (ft)
Tailings						
TP-1	3,930	Eagle Point surface model	16,492	0.38	6.4	12.9
TP-1 (Thin Zone)	70	Eagle Point surface model	3,710	0.09	0.5	0.9
TP-2	2,260	Eagle Point surface model	17,912	0.41	3.4	10.3
TP-3	3,150	Eagle Point surface model	15,851	0.36	5.4	11.7
TP-4	3,170	Eagle Point surface model	33,545	0.77	2.6	9.4
TP-5	900	Eagle Point surface model	15,589	0.36	1.6	2.5
Waste Rock						
WR-1 (West)	150	Eagle Point surface model	3,366	0.08	1.2	4.5
WR-1 (East)	30	Eagle Point surface model	768	0.02	1.1	4.6
WR-2	630	Eagle Point surface model	4,981	0.11	3.4	10.6
WR-2 (West)	639	Eagle Point surface model	7,364	0.17	2.3	7.9
WR-3 (North)	70	Eagle Point surface model	1,458	0.03	1.3	3.5
WR-3 (South)	150	Eagle Point surface model	2,328	0.05	1.7	3.9
Gossan Area	160	Eagle Point surface model	3,073	0.07	1.4	4.9
WR-4	3170	Eagle Point surface model	19,979	0.46	4.3	11.4
WR-4 (Road)	560	Eagle Point surface model	10,698	0.25	1.4	1.5
WR-5	2,280	Eagle Point surface model	18,156	0.42	3.4	14.5
Brandon Mill Waste						
BM	2,750	Eagle Point surface model	42,746	0.98	1.7	2.0
Total Tailings	13,480			2.37		
Total Waste Rock	7,839			1.66		
Brandon Mill Waste	2,750			0.98		
Total	24,069			5.01		

Table 6-3. Mill Tailings Particle Size Results

Sample ID	Weight Percent Retained					Percent Finer by Weight								
	Gravel	Sand			Silt/Clay	Gravel	Sand			Silt/Clay				
Sieve Size	3/4-in	#4	#10	#40	#200	3/4-in	#4	#10	#40	#200	Percent	Percent	Percent	Soil
Opening (Inches)	0.75	0.187	0.0661	0.0106	0.0029	0.75	0.187	0.0661	0.0106	0.0029	Sand	Silt	Clay	Texture
29-451-TP1-1	6.5	9	7.0	15.7	19.6	93.5	84.5	77.5	61.8	42.2	36	42	22	Loam
29-451-TP1-2	<0.1	<0.1	0.1	0.4	2.0	100	100	99.9	99.5	97.5	1	65	34	Silty Clay Loam
29-451-TP1-3	<0.1	1.5	2.8	10.4	26.7	100	100	97.2	86.8	60.1	47	38	15	Loam
29-451-TP2-1	<0.1	1.9	3.8	12.5	19.2	100	98.1	94.3	81.8	62.6	40	46	14	Loam
29-451-TP2-2	<0.1	0.3	3.1	11.2	17.9	100	99.7	96.6	85.4	67.5	39	54	7	Silt Loam
29-451-TP3-1	<0.1	1.1	0.8	4.7	14.6	100	98.9	98.1	93.4	78.8	33	44	23	Loam
29-451-TP3-2	<0.1	<0.1	<0.1	0.2	0.9	100	100	100	99.8	98.9	1	72	27	Silty Clay Loam
29-451-TP3-3	<0.1	0.3	0.9	4.4	18.4	100	99.7	98.8	94.4	76	35	52	13	Silt Loam
29-451-TP4-1	<0.1	<0.1	<0.1	6.7	41.2	100	100	100	93.3	52.1	52	27	21	Sandy Clay Loam
29-451-TP4-2	<0.1	<0.1	<0.1	2.3	5.7	100	100	100	97.7	92	7	64	29	Silty Clay Loam
29-451-TP4-3	<0.1	<0.1	2.4	27.6	43.7	100	100	97.6	70	26.3	74	18	8	Sandy Loam
29-451-TP5-1	<0.1	<0.1	1.8	13.9	38.3	100	100	98.2	84.3	46	57	29	14	Sandy Loam
29-451-TP5-2	<0.1	<0.1	2.6	15.5	41.9	100	100	97.4	81.9	40	59	26	15	Sandy Loam

LEGEND

29-451-TP1-1 is a composite of TP1-1-0-2.8; TP1-3-0-1.6; TP1-2-0-1.7
29-451-TP1-2 is a composite of TP1-1-2.8-5.4; TP1-3-4.2-5.8
29-451-TP1-3 is a composite of TP1-2-3.7-8.0; TP1-1-5.4-9.6; TP1-3-5.8-12.9; TP1-4-3.5-8.3
29-451-TP2-1 is a composite of TP2-4-0-2.1; TP2-1-2.2-3.9
29-451-TP2-2 is a composite of TP2-2-0-5; TP2-3-0.6-4.6; TP2-5-0-4.8; TP2-6-2.1-4.9
29-451-TP3-1 is a composite of TP3-3-0-4.8; TP3-4-0-5.9; TP3-1-0-5.5
29-451-TP3-2 is a composite of TP3-2-0-1.8; TP3-2-1.8-4.9
29-451-TP3-3 is a composite of TP3-2-4.9-8.8; TP3-5-5.4-10.2
29-451-TP4-1 is a composite of TP4-1-0-3.1; TP4-2-0-2.0; TP4-7-0-1.9
29-451-TP4-2 is a composite of TP4-2-2.0-2.6; TP4-4-3.7-5.0; TP4-11-2.5-3.1
29-451-TP4-3 is a composite of TP4-3-0-2.5; TP4-5-0-2.5; TP4-6-0-3.2
29-451-TP5-1 is a composite of TP5-1-0-1.1; TP5-3-0-0.6; TP5-4-0-0.3
29-451-TP5-2 is a composite of TP5-5-0-2.5; BM15-0-1.2

Laboratory analytical data for the four composite samples are summarized in Table 6-1 and contained in Appendix B. The tailings pH is slightly acidic to alkaline ranging from 6.9 to 7.4 standard units (SU). The mean concentrations and the mean concentrations relative to background mean concentrations for analytes with greater than 50 percent of the samples reporting above the method detection limit are as follows: Ag – 7.8 mg/Kg (>3.1x), As – 131.5 mg/Kg (14.6x), Ba – 89.9 mg/Kg (0.59x), Cd – 7.7 mg/Kg (>15.4x), Cr – 28.4 mg/Kg (0.86x), Cu – 229.3 mg/Kg (6.7x), Fe - 31,125 mg/Kg (2.0x), Mn – 887.3 mg/Kg (1.8x), Ni – 32.9 mg/Kg (1.5x), Pb – 1,075.8 mg/Kg (28.7x), and Zn – 1,426 mg/Kg (18.1x). Total cyanide concentrations were below the detection of 0.5 mg/Kg. The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening concentration results with the exception of Cr and Ni which were significantly higher in the XRF method.

The laboratory results indicate that Ag, As, Cd, Cu, Pb, and Zn have average concentrations greater than three times the average background soil concentration.

6.1.2 Tailings Pile TP-2

Tailings pile TP-2 is located in the E½, SE¼ Section 19, Township 4 South and Range 4 West, Montana Principal Meridian (Figure 1-1). The TP-2 tailings area is located immediately to the southwest of TP-1. The topography, test pit locations and details of the TP-2 area are presented in the map on Figure 6-1. The tailings pile TP-2 area was identified during the preliminary assessment work. A small earthen dam is present on the east side of the north-south haul road. During the field work, Olympus extended the boundary of the TP-2 facility to the west of the haul road based on a thin cap of strongly oxidized waste rock and the presence of a tan to light brown silty sand with no gravel or rock immediately beneath the waste rock. The tailings are moderately well vegetated with grasses and sage brush, especially in that portion on the east side of the haul road. Vegetation in the tailings area on the west side of the haul road is sparse.

6.1.2.1 Tailings Pile TP-2 Volume Estimate

The TP-2 tailings volume was estimated using the detailed topographic survey of the tailings surface and the backhoe test pit data. The data were used to evaluate the depth of the tailings and the elevation of the native surface below the tailings. The volume was calculated using the Eagle Point prismoidal method as described in Section 6.1.1.1.

The existing tailings surface model was compiled from the topographic survey. The native surface (Figure 6-2) was triangulated from native surface elevations encountered in the test pits. A total of 5 backhoe test pits (based on later evaluation of the data, test pit TP-2-6 was only used in the assessment of the waste rock pile WR4 area) determined to be were excavated into the TP-2 tailings (Figure 6-1). The estimated volume of the TP-2 tailings is 2,260 cubic yards (Table 6-2). The tailings plan area is 0.41 acres and the average tailings depth is 3.4 feet. The maximum tailings thickness was 10.3 feet.

6.1.2.2 Tailings Pile TP-2 Geology

Backhoe test pits were used to evaluate the tailings contained in the TP-2 area. Test pit logs are contained in Appendix C. The following field observations are summarized from the test pit observations.

The tailings contained in the TP-2 area are predominantly tan to light brown silty sand. The only tailings slimes, 1.7 feet thick, were intersected in test pit TP-2-1 and these were composed of slightly moist, orange brown clayey silt. In the tailings pile TP-2 area, a thin cap of strongly oxidized waste rock or mixed waste rock and tailings covers that portion of the pile near the former mill area. The native soils beneath the tailings generally consist of light brown sand containing gravel and some rock up to 3-inch diameter. Some oxidized lenses were observed in the native soil in TP2-3 test pit. Particle size analyses performed on the TP-2 tailings composite samples are presented in Table 6-3. These results indicate that the tailings are predominantly sandy silts that contain clay concentrations ranging from 7% to 14%.

6.1.2.3 Tailings Pile TP-2 Metal/pH Chemistry Results

Representative samples were collected from backhoe test pits. Samples included vertical channel samples taken from test pit walls and test pit excavation stockpiles. Individual samples were collected based on similar geologic characteristics. Sixteen tailings samples and two representative composite tailings samples were collected from the TP-2 tailings area for XRF screening. In addition, two native soil samples were collected for XRF screening. The XRF results are contained in Appendix A. The TP-2 XRF concentration range results for the principal elements of interest are as follows: As (no detection – 587.6 ppm), Cr (518 – 2,160 ppm), Cu (no detection – 1,929.6 ppm), Fe (14,796.8 - 86,579.2 ppm), Mn (no detection - 2,209.6 ppm), Mo (no detection - 21.1 ppm), Pb (no detection - 5,718.4 ppm), and Zn (111.5 - 3,638.4 ppm). Mercury was not detected via XRF analysis.

Two native soil samples were collected below the tailings for XRF screening analysis. When compared to background soil and the mean element concentrations for tailings pile TP-2, the results suggest that there is some mobilization of Pb and Zn from the tailings into the native soils.

Laboratory analytical data for the two composite samples collected from the TP-2 area are summarized in Table 6-1. The laboratory data and chain-of-custody are contained in Appendix B. The tailings pH is slightly alkaline at 7.9 standard units (SU). The mean concentrations and the mean concentrations relative to background mean concentrations for analytes with greater than 50 percent of the samples reporting above the method detection limit are as follows: As – 8.1 mg/Kg (0.9x), Ba - 180 mg/Kg (1.2x), Cd – 1.5 (>3.0x), Cr – 17 mg/Kg (0.5x), Cu – 58.4 mg/Kg (1.7x), Fe – 15,600 mg/Kg (1.0x), Mn - 403 mg/Kg (0.8x), Ni – 15 mg/Kg (0.7x), Pb – 103 mg/Kg (2.8x), and Zn – 361 mg/Kg (4.6x). Total cyanide was not detected above the detection limit of 0.5 mg/Kg. The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening concentration results with the exception of Cr, Mn, and Ni which were significantly higher in the XRF method. The analytes with an average concentration greater than or equal to three times the average background soil concentration include Cd and Zn.

6.1.3 Tailings Pile TP-3

Tailings pile TP-3 is located in the E½, SE¼ Section 19, Township 4 South and Range 4 West, Montana Principal Meridian (Figure 1-1). The TP-3 tailings pile is located immediately downslope from the tailings pile TP-2 dam. The TP-3 tailings impoundment was constructed with a small berm located at the southwest end of the TP-3 area. The tailings are sparsely vegetated. Figure 6-1 presents the topography and location of backhoe test pits used in the assessment of tailings pile TP-3.

6.1.3.1 Tailings Pile TP-3 Volume Estimate

The TP-3 tailings volume was estimated using the detailed topographic survey of the tailings surface and backhoe test pit data. The data were used to evaluate the depth of the tailings and the elevation of the native surface below the tailings (Figure 6-2). The volume was calculated using the Eagle Point prismoidal method as described in Section 6.1.1.1.

Four backhoe test pits were excavated into the TP-3 tailings and a single test pit, TP-3-1, was excavated to investigate a possible overflow area from TP-2 (Figure 6-1). The estimated volume of the TP-3 tailings is 3,150 cubic yards (Table 6-2). The tailings plan area is 0.36 acre and the average tailings depth is 5.4 feet. The maximum tailings thickness measured in the holes was 11.7 feet.

6.1.3.2 Tailings Pile TP-3 Geology

The TP-3 tailings pile consists of predominantly tan to light brown, silty sands with lesser tailings slimes consisting of bluish gray silty clay to brown clayey silt. The slime zones generally show fine banding and may exhibit orange brown FeOx coloration. All test pits intersected native soil which consisted of light greenish gray, fine to medium-grained sand with gravel and rock generally less than 3-inch diameter. In the tailings pile area, the native soils showed variable yellow to orange brown FeOx in test pits TP-3-4 and TP-3-5. No moisture of any significance was observed in the tailings or native soils below the tailings.

Particle size analyses for selected tailings intervals are summarized in Table 6-3 and contained in Appendix B. Representative composite samples of the tan to light brown silty sand, bluish gray/brown silty clay to clayey silt, and tan silty sand were selected for particle size analysis. The analytical results indicate sandy silt with 23% clay, clayey silt, and sandy silt with 13% clay, respectively.

6.1.3.3 Tailings Pile TP-3 Metals/pH Chemistry Results

Representative tailings samples were collected from backhoe test pits. Samples included vertical channel samples taken from test pit walls and samples collected from test pit excavation stockpiles. Individual samples were collected based on similar geologic characteristics. Ten tailings samples and three representative composite tailings samples were collected from the TP-3 tailings area for XRF screening. In addition, three native soil samples were collected from below the tailings for XRF screening. The XRF results are contained in Appendix A. The TP-3 XRF concentration range results for the principal elements of interest are as follows: As (no detection – 270.8 ppm), Cu (no detection – 552 ppm), Fe (15,692.8 – 53,555.2 ppm), Hg (no detection – 99.1 ppm), Mn (no detection - 2,268.8 ppm), Mo (no detection – 60.6 ppm), Pb (no detection – 4,988.8 ppm), and Zn (71.5 – 1,748.8 ppm).

Three native soil samples were collected below the tailings for XRF screening analysis. When compared to background soil and the mean element concentrations for tailings pile TP-3, the results suggest that there is some mobilization of Mn and Zn from the tailings into the native soils. Although XRF Cr is elevated in the native soils, the accuracy of the XRF method for Cr is questionable. A review of the analytical data for tailings composite samples shows that the quantitative laboratory method results are significantly lower than the qualitative to semi-quantitative XRF method.

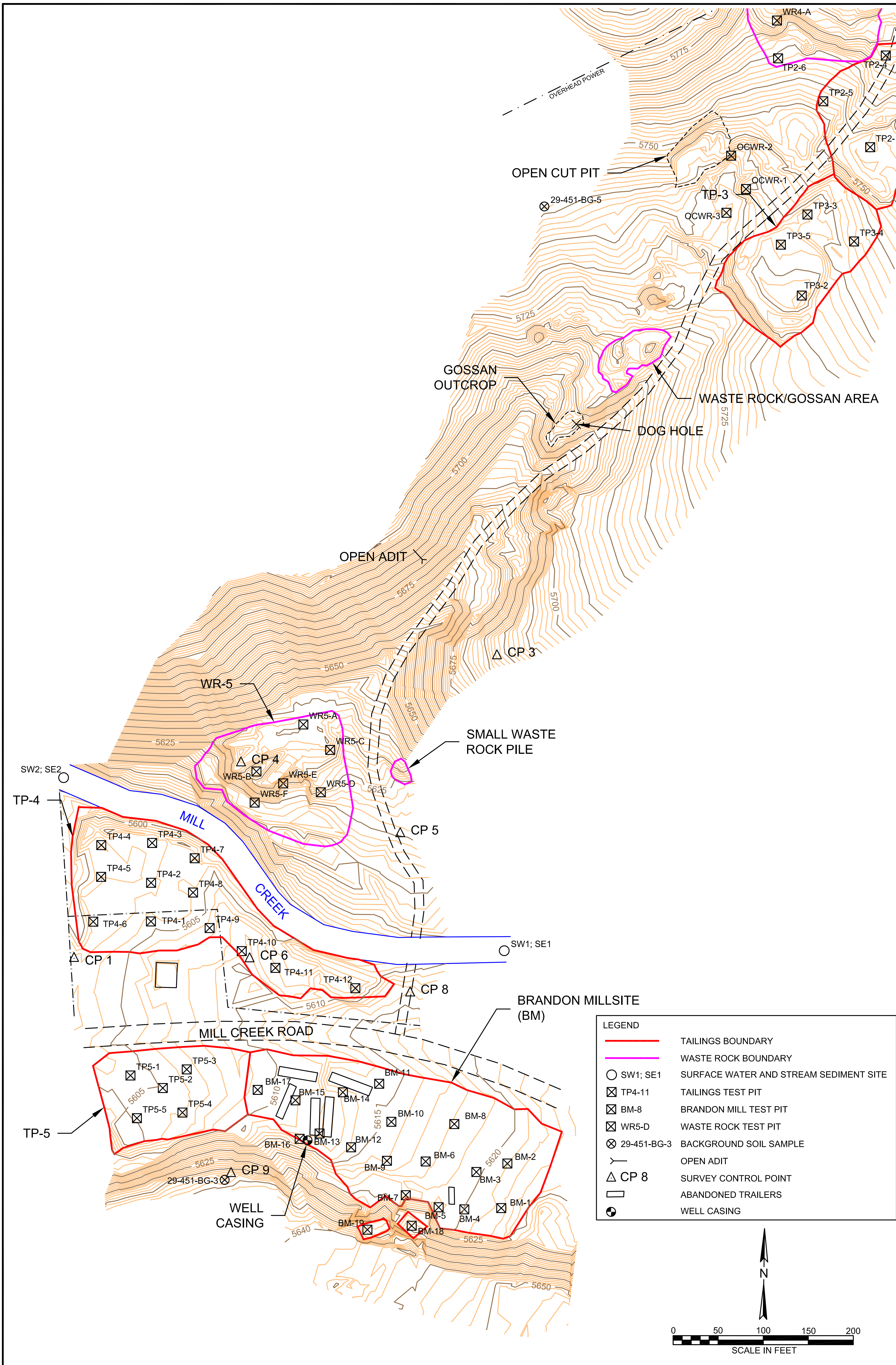
Laboratory analytical data for the three composite samples collected from the TP-3 area are summarized in Table 6-1. The laboratory data and chain-of-custody are contained in Appendix B. The tailings pH is slightly alkaline ranging from 7.5 to 8.0 standard units (SU). The mean concentrations and the mean concentrations relative to background mean concentrations for analytes with greater than 50 percent of the samples reporting above the method detection limit are as follows: As – 177.4 mg/Kg (19.7x), Ba – 111.2 mg/Kg (0.7x), Cd – 3.5 (>7.0x), Cr – 17.5 mg/Kg (0.5x), Cu – 505 mg/Kg (14.7x), Fe – 28,300 mg/Kg (1.9x), Mn – 462 mg/Kg (0.9x), Ni – 20.1 mg/Kg (0.9x), Pb – 1,904.8 mg/Kg (50.8x), and Zn – 308.3 mg/Kg (3.9x). Total cyanide was not detected above the lower detection limit of 0.5 mg/Kg. Silver (Ag) was detected in only one sample at a concentration of 59.7 mg/Kg. The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Ag, As, Cd, Cu, Pb, and Zn.

6.1.4 Tailings Pile TP-4

Tailings pile TP-4 is located in the E½, SE¼ Section 19, Township 4 South and Range 4 West, Montana Principal Meridian (Figure 1-1). The northern boundary of the tailings pile is juxtaposed against the south side Mill Creek. A barbed-wire fence encompasses the majority of tailings pile TP-4 with the exception of the southwestern portion. The tailings are sparsely vegetated with large areas of the surface exposed. The surface area is variably oxidized as evidenced by the orange to red to yellow brown FeOx coloration. A thin crust has developed on much of the tailings, but this crust is easily breached as evidenced by deer footprints. White salts are common on the surface in the exposed tailings areas. Minor metal wire debris and a tree limb brush pile are present on the tailings within the fenced area. Some test pits intersected wooden timber materials and some metal debris at depth in the tailings pile. Stormwater/snowmelt runoff has breached the northern tailings berm in the northeastern portion of the tailings pile. The tailings have been eroded into Mill Creek and the small channel area is now cut to native cobbles. The cobbles show various degrees of red to orange brown coloration due to iron oxide coatings. A residence with a well house is located within 100 feet to the southwest of the TP-4 tailings pile (Figure 1-2).

6.1.4.1 Tailings Pile TP-4 Volume Estimate

A detailed survey of the TP-4 area was completed and the topographic map is shown on Figure 6-3. The TP-4 tailings volume was estimated using the detailed topographic survey of the TP-4 area and the backhoe test pit and shovel/hand auger hole data.



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MONTANA DEQ/MINE WASTE CLEANUP BUREAU
BUCKEYE MINE SITE
MADISON COUNTY, MONTANA

LOWER BUCKEYE MINE SITE AND BRANDON MILL AREA

FIGURE 6-3

DESIGN:	DRAWN: KSR	CHECKED: CRS	APPROVED:	DATE: 12/2004	JOB NO: A1431	SCALE: AS SHOWN	FILENAME: A1431Buckeye.dwg

The volume of the TP-4 tailings was calculated using an Eagle Point surface model. The existing tailings surface model was compiled from the topographic survey. The native surface (Figure 6-4) was triangulated from native surface elevations encountered in the backhoe test pit and shovel/hand auger holes. One backhoe test pit and 11 shovel/hand auger holes were excavated into the TP-4 tailings area (Figure 6-3). The estimated tailings volume of the TP-4 area is 3,170 cubic yards. Tailings pile TP-4 occupies the largest area of any of the Buckeye tailings impoundments. The tailings plan area is 0.77 acre and the average tailings depth and maximum thickness are 2.6 feet and 9.4 feet, respectively.

6.1.4.2 Tailings Pile TP-4 Geology

The tailings in the TP-4 area are variably-colored silty sand to sand with lesser clayey silt. The non-oxidized silty sand and sand tailings vary in color from tan to light brown to gray. Much of the surface and most holes show various degrees of iron oxidation manifested as orange to yellow brown coloration. The finer-grained tailings are predominantly bluish gray with lesser light tan clayey silts to silty clays. The bluish gray clayey silt slimes intersected in test hole TP4-4 were moderately saturated and the hole was slumping near the bottom. The test hole data indicate that the deepest portion of the TP-4 tailings is in the northwestern portion and this area contains the thicker sections (≤3.6 feet) of slime tailings. White salts are present on much of the exposed tailings surface. Based on the concentration of tracks in the salt areas, deer frequently visit these sites probably to consume the salts.

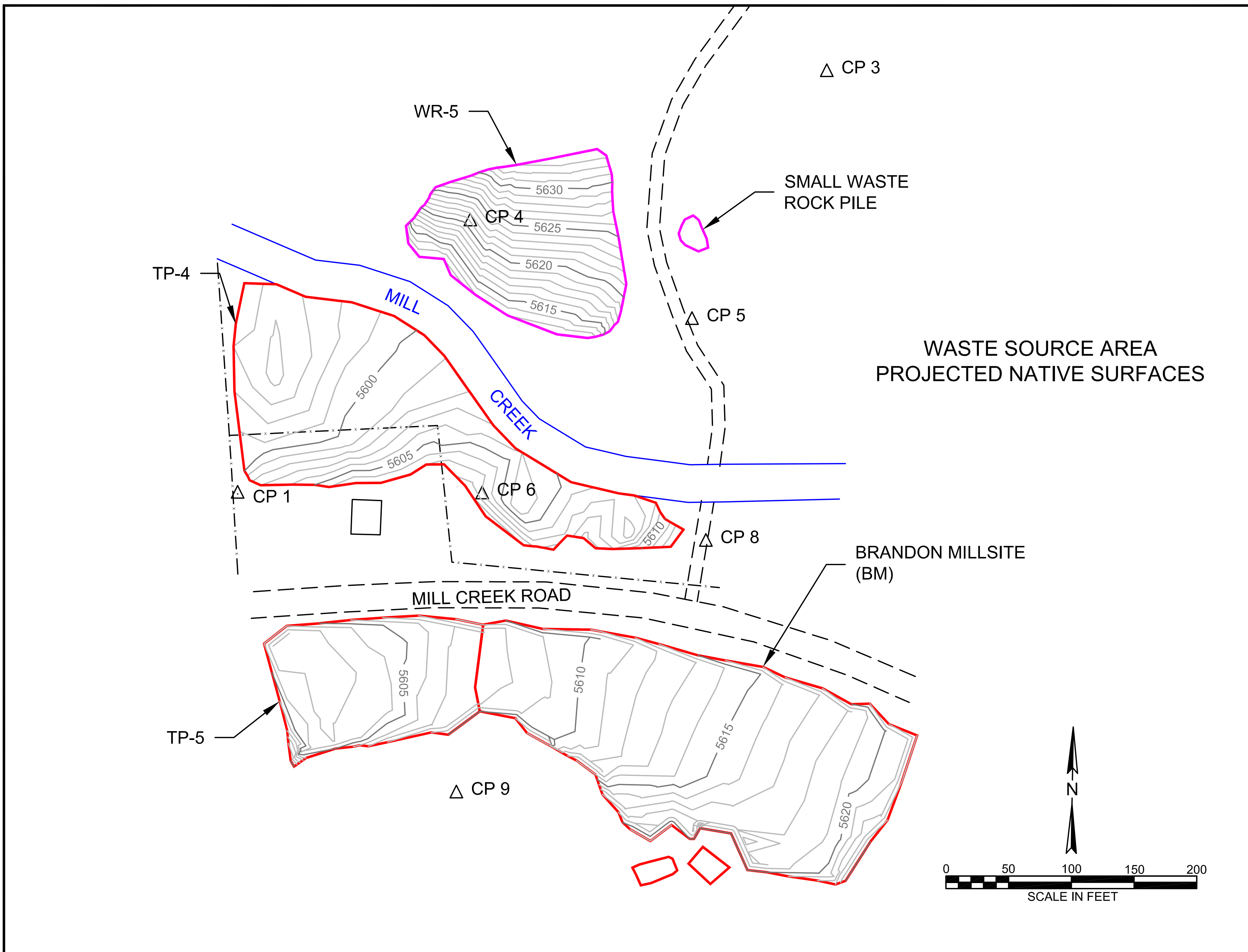
Most of the test holes intersected native soils composed predominantly of dark brown sand with variable concentrations of gravel and lesser rock up to 3-inch diameter. The native soils exposed and intersected in test holes in the southeastern portion of TP-4 tailings exhibit strong oxidation with dark reddish brown to red coloration. In this area, the tailings are thin and tailings have been eroded via stormwater/snowmelt runoff.

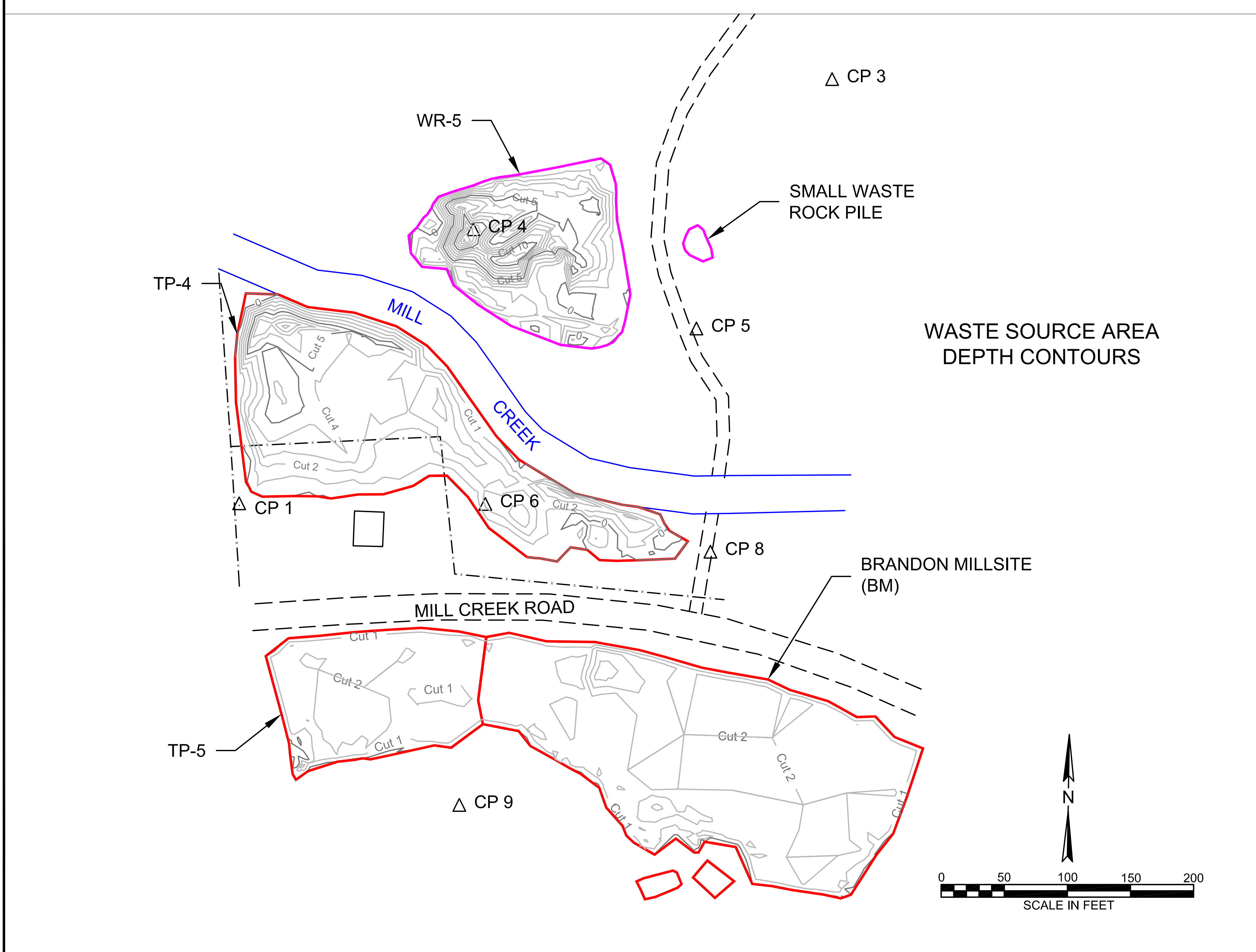
Particle size analyses for selected tailings intervals are summarized in Table 6-3 and contained in Appendix B. The laboratory analysis for the representative samples of oxidized silty sand, bluish gray clayey silt to silty clay, and non-oxidized silty sand to sand tailings from TP-4 indicates that these tailings are silty sand with 21% clay, clayey silt, and silty sand with 8% clay, respectively.

6.1.4.3 Tailings Pile TP-4 Metals/pH Chemistry Results

Representative samples were collected from vertical channel samples taken from shovel pit or backhoe pit walls or from grab samples collected from the excavation stockpiles or hand auger borings. Individual samples were collected based on similar geologic characteristics. Fifteen tailings samples and three representative composite tailings samples were collected from the TP-4 area. In addition, six native soil samples were collected for XRF screening. The XRF results are contained in Appendix A.

The TP-4 tailings XRF concentration range results for the principal elements of interest are as follows: As (no detection – 291.8 ppm), Cr (546.4 – 3,628.8 ppm), Cu (no detection – 3,308.8 ppm), Fe (11,596.8 – 12,792 ppm), Mn (no detection – 1,229.3 ppm), Mo (no detection – 26.9 ppm), Pb (1,040 – 12,896 ppm), and Zn (172.8 – 20,697.6 ppm). Mercury was detected only in a single sample at 125.3 ppm. One representative sample (TP4-SALT) was collected of the white salts on the tailings surface for XRF analysis. The result indicated elevated





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BUCKEYE MINE SITE
MADISON COUNTY, MONTANA

LOWER BUCKEYE MINE AREA
PROJECTED NATIVE SURFACE
AND DEPTH CONTOURS

FIGURE
6-4

DESIGN:	DRAWN: KSR	CHECKED: CRS	APPROVED:	DATE: 12/2004	JOB NO: A1431	SCALE: AS SHOWN	FILENAME: A1431Buckeye.dwg

concentrations of Cr (2,228.8 mg/Kg), (Cu (445.6 mg/Kg), Ni (4,038.4 mg/Kg), Pb (1200 mg/Kg) and Zn (13,299.2 mg/Kg). Quantitative laboratory results for tailings composite samples indicate that the XRF results are much higher for Cr and Ni, thus the XRF accuracy for these elements is questionable.

Five representative native soil samples from beneath the tailings were collected for XRF screening. A single composite sample of a small soil stockpile in the area of the TP-4 tailings was also collected for XRF screening analysis. The results suggest some mobilization of Zn from the tailings into the native soils. The fact that Cd concentrations have been shown to correlate with Zn, it is probable that there is also some mobilization of this element. The Cr and Ni XRF results are also elevated, but as discussed earlier, these results are questionable. Although mercury was also detected in most of the native soil samples, XRF has proven to be an unreliable method for analysis of this element.

Laboratory analytical data for the three composite samples collected from the TP-4 area are summarized in Table 6-1. The laboratory data and chain-of-custody are contained in Appendix B. The tailings pH is acidic to near neutral ranging from 5.9 to 7.4 standard units (SU). The mean concentrations and the mean concentrations relative to background mean concentrations for analytes with greater than 50 percent of the samples reporting above the method detection limit are as follows: Ag – 32.5 mg/Kg (>13.0x), As – 223.3 mg/Kg (24.8x), Ba – 43.9 mg/Kg (0.3x), Cd – 50.2 (>100.4x), Cr – 9.4 mg/Kg (0.3x), Cu – 1,004 mg/Kg (29.2x), Fe – 28,933.3 mg/Kg (1.9x), Hg – 2.0 mg/Kg (>4.1x), Mn – 787.7 mg/Kg (1.6x), Ni – 20.7 mg/Kg (0.9x), Pb – 3,976.7 mg/Kg (106.0x), Sb – 25.0 mg/Kg (>10.0x), and Zn – 7,550 mg/Kg (95.8x). Total cyanide was not detected above the lower detection limit of 0.5 mg/Kg. The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Ag, As, Cd, Cu, Hg, Pb, Sb and Zn.

6.1.5 Tailings Pile TP-5

The tailings pile TP-5 is located in the E½, SE¼ Section 19, Township 4 South and Range 4 West, Montana Principal Meridian (Figure 1-1). This small tailings area occurs on the south side of Mill Creek road to the south of tailings pile TP-4. The tailings are bounded on the west by a small tailings dam or berm. The size of the trees growing in this berm indicates that the dam is relatively old. The orientation of this dam is such that it is on-line with the TP-4 dam located to the north across Mill Creek road. The tailings are sparsely vegetated with grass and weeds. A residence with a well house is located within 50 feet to the west of the TP-5 tailings dam (Figure 1-2).

6.1.5.1 Tailings Pile TP-5 Volume Estimate

A detailed survey of the TP-5 tailings area was completed and the topographic map is shown on Figure 6-3. The TP-5 area tailings volume was estimated using the detailed topographic survey of the TP-5 tailings surface and the shovel/auger hole data. The test pit data were used to evaluate the depth of the tailings and the elevation of the native surface. The volume was calculated using the Eagle Point prismoidal method as described in Section 6.1.1.1. The native surface elevations were plotted and the native surface below the tailings (Figure 6-4) was reconstructed into a surface model that fit the test pit data and topography surrounding the tailings.

Five shovel/hand auger holes were excavated to evaluate the TP-5 tailings area. The estimated tailings volume of TP-5 is 900 cubic yards. The tailings plan area is 0.36 acres and the average tailings depth and the maximum thickness are 1.6 and 2.5 feet, respectively.

6.1.5.2 Tailings Pile TP-5 Geology

The TP-5 tailings are predominantly light brown silty sands with lesser light green to beige colored silty clays. The tailings are generally non-oxidized with the exception of occasional light orange brown FeOx.

Particle size analyses for selected tailings intervals are summarized in Table 6-3 and contained in Appendix B. The laboratory analyses for representative samples of light brown silty sand and oxidized silty sand tailings from TP-5 indicate that both of these tailings are silty sands containing up to 15% clay.

The native soils beneath the tailings are chocolate brown silty sands with gravel. The contact between tailings and native soil is generally sharp and FeOx is distinctly absent in the native soil near the contact zone.

6.1.5.3 Tailings Pile TP-5 Metals/pH Chemistry Results

Representative samples were collected from vertical channel samples taken from shovel test pit walls. Individual samples were collected based on similar geologic characteristics. Six tailings samples and two representative composite tailings samples were collected from the tailings pile TP-5 area for XRF screening. In addition, two native soil samples were collected for XRF screening. The XRF analytical results are summarized in Appendix A. The TP-5 tailings XRF concentration range results for the principal elements of interest are as follows: As (no detection – 238.4 ppm), Cr (941.6 – 101,990.4 ppm), Cu (no detection – 430 ppm), Fe (25,190.4 – 283,385.8 ppm), Mo (no detection – 457.2 ppm), Ni (no detection – 40,576 ppm), Pb (213.2 – 2,520 ppm), and Zn (283.2 – 3,000 ppm).

Laboratory analytical data for the two composite samples collected from the TP-5 area are summarized in Table 6-1. The laboratory data and chain-of-custody are contained in Appendix B. The tailings pH is acidic ranging from 4.7 to 6.1 standard units (SU). The mean concentrations and the mean concentrations relative to background mean concentrations for analytes with greater than 50 percent of the samples reporting above the method detection limit are as follows: Ag – 17.3 mg/Kg (>6.9x), As – 164 mg/Kg (18.2x), Ba – 72.9 mg/Kg (0.5x), Cd – 11.0 mg/Kg (>22.0x), Cr – 24.6 mg/Kg (0.7x), Cu – 372.5 mg/Kg (10.8x), Fe – 25,900 mg/Kg (1.7x), Hg – 1.5 mg/Kg (>3.0x), Mn – 432.5 mg/Kg (0.9x), Ni – 20.5 (0.9x), Pb – 2,170 mg/Kg (57.9x), Sb – 7.1 mg/Kg (>2.8x), and Zn – 1,960 mg/Kg (24.9x). Total cyanide was not detected above the lower detection limit of 0.5 mg/Kg. The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Ag, As, Cd, Cu, Hg, Pb, and Zn.

The mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening concentration results with the exception of Cr and Ni which were significantly higher in the XRF method and Mn, with the exception of a single sample, was not detected in XRF analysis.

Two representative native soil samples below the tailings were collected for XRF screening. The XRF results indicate that Zn and Pb (in one sample) are elevated greater than 3 times background soil concentrations. The XRF results indicate that both Cr and Ni are also elevated in the native soils beneath the tailings, but these data are suspect as discussed earlier.

6.2 MILL TAILINGS PILES ACID-BASE ACCOUNTING RESULTS

The mill tailings in the Buckeye Mine project area generally show some oxidation especially in the upper zones of the tailings. This is evidenced by orange to yellow to red brown FeOx in the tailings. The tailings piles, TP-1, TP-2 and TP-3, located in the northern portion of the Buckeye Mine site are generally slightly alkaline in pH. The two tailings piles, TP-4 and TP-5, located in the southern portion of the site are more acidic with pH as low as 4.7 S.U. Tailings pile TP-4 is the most intensely oxidized tailings and contains moderately abundant white salts on the surface.

The modified Sobek method was used to evaluate the acid generating potential of the mill tailings present in the Buckeye Mine site area. A total of thirteen composite samples and one duplicate composite sample were collected for ABA analyses at Energy Laboratories, Inc. The acid-base accounting laboratory analytical results are contained in Appendix B and summarized in Table 6-4. The ABA data indicate that the total sulfur concentrations in the mill tailings are variable ranging from 0.03% to 5.0%. All of the composite samples collected from tailings piles TP-1, TP-2 and TP-3 show positive net neutralization potential (NNP) ranging from +21 to +167 tons per 1000 tons $CaCO_3$ (t/1000t $CaCO_3$). The acid-base accounting results for TP-1, TP-2 and TP-3 suggest that the potential for acid rock drainage is limited.

Tailings piles TP-4 and TP-5 ABA data results show NNP ranging from +32 to -108 t/1000t $CaCO_3$. The results indicate that these tailings have the potential to produce acid rock drainage. The field characteristics and current pH data, especially in tailings pile TP-4, support the ABA results. These tailings are currently acidic, show moderately strong oxidation and are developing white salt deposits on the exposed tailings. The production of acid rock drainage is further corroborated in the southeastern portion of TP-4 where strong reddish brown FeOx staining is evident on stream cobbles. In this area, stormwater/snowmelt runoff has eroded the tailings down to the native surface composed predominantly of stream gravel and cobbles. This area was likely a former tributary stream channel to Mill Creek. The TP-4 and TP-5 tailings also contain higher overall total sulfur concentrations (1.0% to 5.0%) in comparison to the other tailings in the Buckeye Mine site area.

6.3 MILL TAILINGS PILES TCLP RESULTS

Based on the laboratory analytical results for the mill tailings, splits of composite samples were selected for metals (Ag, As, Ba, Cd, Cr, Hg, Pb, and Se) Toxicity Characteristic Leaching Procedure (TCLP) analysis. For the eight Resource Conservation and Recovery Act (RCRA) metals, chemistry results for mill tailings show that cadmium, lead and mercury are the elements of most concern in the mill tailings contained in the Buckeye Mine site. Based on the laboratory analytical results, four composite mill tailings samples elevated in one or more of these elements were selected for TCLP analysis at Energy Laboratories, Inc.

The tailings TCLP laboratory analytical results are contained in Appendix B and are summarized in Table 6-5. The results indicate that lead exceeded the regulatory levels for metal toxicity

Table 6-4. Acid-Base Accounting Results For Mill Tailings, Waste Rock and Brandon Mill Wastes

Sample ID	Total Sulfur (%)	Pyritic Sulfur (%) HNO_3 Ext. S	Sulfate Sulfur (%) HCL Ext. S	Residual Sulfur (%)	Acid Gen Potential *	Neutraliz Potential *	Acid/Base Potential *
Buckeye Mine Tailings							
29-451-TP1-1	1.1	0.74	0.17	0.22	23	44	21
29-451-TP1-2	1.5	1.4	0.07	0.09	42	72	30
29-451-TP1-3	0.22	0.02	0.20	<0.01	<1.0	117	116
29-451-TP2-1	0.04	0.02	0.02	<0.01	<1.0	130	129
29-451-TP2-2	0.03	<0.01	0.02	<0.01	<1.0	128	128
29-451-TP3-1	0.03	<0.01	0.02	<0.01	<1.0	167	167
29-451-TP3-2	0.62	0.55	0.04	0.03	17	52	35
29-451-TP3-3	0.19	<0.01	0.18	<0.01	<1.0	106	106
29-451-TP4-1	1.0	0.73	0.21	0.05	23	27	3.9
29-451-TP4-2	5.0	4.2	0.24	0.56	132	24	-108
29-451-TP4-3	2.0	1.6	0.22	0.21	49	82	32
29-451-TP5-1	0.66	0.21	0.38	0.07	6.5	5.0	-1
29-451-TP5-2	1.1	0.52	0.54	0.08	16	14	-2
29-451-TP6-1	2.1	0.84	0.88	0.39	26	51	25
Buckeye Mine Waste Rock							
29-451-WR-1	1.9	0.59	0.65	0.65	18	48	30
29-451-WR-2	0.02	0.01	<0.01	<0.01	<1.0	46	46
29-451-WR4-1	3.1	1.4	1.4	0.33	43	1.3	-40
29-451-WR4-2	2.5	1.6	0.43	0.55	49	26	-23
29-451-WR5-1	3.5	1.3	1.6	0.60	41	10	-30
29-451-WR5-2	3.4	1.3	1.8	0.30	41	<1.0	-40
Brandon Mill Wastes							
29-451-BM-1	2.4	1.0	0.93	0.43	32	5.9	-26.1
29-451-BM-2	1.7	0.62	0.71	0.36	19	<1.0	-20
29-451-BM-3	7.6	4.5	1.5	1.6	142	<1.0	-142
29-451-BM-4	2.1	1.3	0.66	0.10	42	41	-0.5

* Tons of $CaCO_3$ equivalent per 1000 tons of material

LEGEND
See Table 6-1 and Table 6-6 for sample descriptions

Table 6-5. TCLP Metals for Mill Tailings, Waste Rock and Brandon Mill Wastes

Sample ID	Ag (mg/L)	As (mg/L)	Ba (mg/L)	Cd (mg/L)	Cr (mg/L)	Hg (mg/L)	Pb (mg/L)	Se (mg/L)
Tailings								
29-451-TP1-1	<0.5	<0.5	<10	0.3	<0.5	<0.02	1.4	<0.1
29-451-TP3-2	<0.5	<0.5	<10	0.1	<0.5	<0.02	**11.7**	<0.1
29-451-TP4-2	<0.5	<0.5	<10	0.8	<0.5	<0.02	**73.6**	<0.1
29-451-TP5-2	<0.5	<0.5	<10	0.3	<0.5	<0.02	2.4	<0.1
Waste Rock								
29-451-WR-1	<0.5	<0.5	<10	0.5	<0.5	<0.02	1.1	<0.1
29-451-WR4-2	<0.5	<0.5	<10	0.2	<0.5	<0.02	**80.5**	<0.1
29-451-WR5-1	<0.5	<0.5	<10	0.9	<0.5	<0.02	**8.3**	<0.1
Brandon Mill Waste								
29-451-BM-1	<0.5	<0.5	<10	0.3	<0.5	<0.02	**12.1**	<0.1
Regulatory Level	5	5	100	1	5	0.2	5	1

LEGEND

29-451-TP1-1 is a composite of TP1-1-0-2.8, TP1-3-0-1.6 and TP1-2-0-1.7
29-451-TP3-2 is a composite of TP3-2-0-1.8 and TP3-2-1.8-4.9
29-451-TP4-2 is a composite of TP4-2-2.0-2.6, TP4-4-3.7-5.0 and TP4-11-2.5-3.1
29-451-TP5-2 is a composite of TP5-5-0-2.5 and BM15-0-1.2
29-451-WR-1 is a composite of WR2-B, WR1-A, WR2-C, and WR1-C
29-451-WR4-2 is a composite of WR4-B-3.7-5.7 and WR4-C-4.3-5.9
29-451-WR5-1 is a composite of WR5-A-0-1.8, WR5-C-0-2.0 and WR5-E-0-2.0
29-451-BM-1 is a composite of BM1-0-0.5, BM4-0-1.0 and BM5-0-0.7

under the RCRA rules for hazardous waste classification in the TP-3 and TP-4 tailings piles. Cadmium was detected in all of the leachates, but at concentrations within the regulatory limit. The highest cadmium leachate concentration (0.8 mg/L) was detected in tailings pile TP-4. Arsenic, barium, chromium, mercury, selenium and silver were not detected in any of the tailings composite sample leachates above the lower detection limit of 0.02 mg/L. The TCLP data suggest that Pb and Cd have the potential to leach from the TP-3 and TP-4 tailings.

6.4 BUCKEYE MINE WASTE ROCK PILES (WR-1 THROUGH WR-5)

The Buckeye Mine site waste rock piles are located in SE¼ Section 19 and SW¼ Section 20, Township 4 South and Range 4 West, Montana Principal Meridian (Figure 1-1). Waste rock piles WR-1 through WR-4 (Figure 6-1) are located in the northern portion of the Buckeye Mine site to the east of the former mill site and an ephemeral tributary of Mill Creek. Waste rock pile WR-5 (Figure 6-3) is located on the north side of Mill Creek in the southern portion of site.

The waste rock piles WR1 through WR-3 are small piles associated with limited underground mine workings. Collapsed adits are evident upslope from WR-1 and WR-2 and to the north of WR-3. Based on the lush grass vegetation pattern, the adit near waste rock pile WR-2 is periodically seeping water. The rock piles are generally devoid of vegetation or are only sparsely vegetated with the exception of waste rock pile WR-3. This pile is moderately well vegetated with grasses and sage brush, especially on the southern-most pile.

Waste rock piles WR-4 and WR-5 are the largest areas of waste rock contained in the Buckeye Mine site project area. Waste rock pile WR-4 includes much of the former mill area and waste rock located along the access road to the mill site. The two small wooden buildings associated with the mill site are located on top of this waste rock pile. A concrete pad approximately 60 feet by 40 feet with a small wooden hopper structure is located immediately to the west of waste rock pile WR-4. This is the site of the former mill building. A wooden headframe with track for an ore car dump station and an ore bin structure occurs just to the north of the northern boundary of waste rock pile WR-4. The ore bin contains some residual ore. Waste rock pile WR-5 is the southern-most pile at the site and is a strongly oxidized pile with nil vegetation. Some minor wood and metal and a small concrete foundation are associated with this pile.

Some minor wood and metal debris are present in the area of the other the waste rock piles. Minor 2-inch diameter PVC pipe and plastic sheeting is located near the toe of waste rock pile WR-2.

6.4.1 Buckeye Mine Waste Rock Piles Volume Estimates

Topographic surveys were completed on the four waste rock piles (WR-1 through WR-5) in the Buckeye Mine site area (Figures 6-1 and 6-3). The survey data were used to calculate volume estimates for the waste rock piles.

Waste rock pile WR-1 is located to the northeast of tailings pile TP-1 area (Figure 6-1) on the east side of an ephemeral drainage. Waste rock pile WR-1 consists of two small piles, the larger is adjacent to the ephermal drainage and the smaller is located up the slope to the east. A detailed topographic survey of WR-1 was completed and used to estimate the waste rock volume. The volume was calculated using Eagle Point surface models of the waste rock pile surface and the projected native surface below the pile. No test pits were excavated to the bottom of the rock pile because of the coarseness of the material and the instability of test pit walls. Therefore, the native surface below the pile was estimated by projecting from the native topography adjacent to the waste rock pile. The projected native surface and depth contours are shown on Figure 6-2.

Table 6-2 summarizes the volume calculation results for WR-1. The estimated volume of WR-1 (west and east piles) is 180 cubic yards. The combined plan area of WR-1 is 0.10 acres and the average and maximum waste rock depths are 1.2 feet and 4.5 feet for the west pile and 1.1 feet and 4.6 feet for the east pile.

Waste rock pile WR-2 is located to the east of tailings pile TP-1 (Figure 6-1). The waste rock pile area is composed of two defined piles of nearly equal volumes. The slightly larger pile is located within the ephemeral drainage where it appears to have been used to build a haul road across the drainage. The infilling of the ephemeral drainage with waste rock has formed a dam across the drainage. A loading dock, constructed of logs and waste rock with dimensions of 19 wide by 37 foot long by 4 feet high, is located in the northeast corner of this waste rock pile. The other portion of waste rock pile WR-2 is located on the east side of the ephemeral drainage and its toe is adjacent to the drainage. A collapsed adit is located to the northeast and upslope from the waste rock pile. The two piles were differentiated based on geology which will be discussed later. A detailed topographic survey of WR-2 was completed and used to estimate the waste rock volumes. The volumes were calculated using Eagle Point surface models of the waste rock pile surfaces and the projected native surface below the piles. No test pits were excavated in the waste rock pile to the native surface because of the coarseness of the material and the instability of the test pit walls. Therefore, the native surfaces below the piles were estimated by projecting from the native topography adjacent to the waste rock piles. The projected native surfaces and depth contours are shown on Figure 6-2. Table 6-2 summarizes the volume calculation results for WR-2. The total estimated volume of WR-2 is 1,269 cubic yards. The total plan area of WR-2 is 0.28 acres and the average and maximum waste rock depths are 3.4 feet and 10.6 feet for WR-2 and 2.3 and 7.9 for WR-2 West.

Waste rock pile WR-3 is located to the southeast of WR-2 (Figure 6-1). The waste rock pile area is comprised of two small piles aligned nearly north and south. A collapsed adit is located near the northern-most pile of WR-3. A detailed topographic survey of the WR-3 piles was completed and used to estimate the waste rock volumes. The volumes were calculated using Eagle Point surface models of the waste rock pile surfaces and the projected native surfaces below the piles. No test pits were excavated in the waste rock pile to the native surface because of the coarseness of the material and the steep slope of the face. Therefore, the native surface below the pile was estimated by projecting from the hill slopes adjacent to the waste rock pile. The projected native surfaces and depth contours are shown on Figure 6-2. Table 6-2 summarizes the volume calculation results for WR-3. The total estimated volume of WR-3 is 225 cubic yards. The total plan area of WR-3 is 0.08 acres and the average and maximum waste rock depths of the north pile are 1.3 feet and 3.5 feet and 1.7 feet and 3.9 feet for the south pile.

Waste rock pile WR-4 is comprised of two areas, the larger of which is located to the west of the former mill site concrete pad. A second area of oxidized waste rock is associated with the north-south portion of the access road to the former mill site (Figure 6-1). A detailed topographic survey of WR-4 was completed and used to estimate the waste rock volume. The volume was calculated using Eagle Point surface models of the waste rock pile surface and the projected native surface below the pile. Some backhoe test pits were excavated in the waste rock pile to the native surface. These data were used to estimate the native surface below the piles. The projected native surface and depth contours are shown on Figure 6-2. Table 6-2 summarizes the volume calculation results for WR-4. The estimated total volume of WR-4 is 4,270 cubic yards. The total plan area of WR4 is 0.71 acres and the average and maximum waste rock depth for the main pile are 4.3 feet and 11.4 feet and 1.4 feet and 1.5 feet for the WR-4 Road area.

Waste rock pile WR-5 is located just to the north of Mill Creek (Figure 6-3). The waste rock area consists of one main pile. A small pile is located to the east of the main pile and only a visual estimate (±10 cubic yards) of the volume was made. A detailed topographic survey of the WR-5 main pile was completed and used to estimate this waste rock volume. The volume was calculated using an Eagle Point surface model of the waste rock pile surface and the projected native surfaces below the pile. No test pits were excavated in the waste rock pile to the native surface because of the coarseness of the material and the steep slope of the face. Therefore, the native surface below the pile was estimated by projecting from the hill slopes adjacent to the waste rock pile. The projected native surfaces and depth contours are shown on Figure 6-4. Table 6-2 summarizes the volume calculation result for WR-5. The total estimated volume of WR-5 is 2,280 cubic yards (estimated 2,290 cubic yards with small pile). The plan area of WR-5 is 0.42 acres and the average and maximum waste rock depth are 3.4 feet and 14.5 feet, respectively.

A small waste rock pile composed principally of iron oxide-rich gossan is located to the southwest of tailings pile TP-3. This material appears to have been excavated from a small adit (dog hole) constructed in a silica-rich gossan rock outcrop (Figure 6-1). A detailed topographic survey of the gossan area was completed and used to estimate this waste rock volume. The volume was calculated using an Eagle Point surface model of the waste rock pile surface and the projected native surfaces below the pile. No test pits were excavated in the waste rock pile. Therefore, the native surface below the pile was estimated by projecting from the hill slopes adjacent to the waste rock pile. The projected native surface and depth contours are shown on Figure 6-2. Table 6-2 summarizes the volume calculation result for gossan waste rock area. The total estimated volume is 160 cubic yards. The plan area of the gossan is 0.07 acres and the average and maximum waste rock depth are 1.4 feet and 4.9 feet, respectively.

A small open-cut pit area is located to the northwest of tailings pile TP-3. The pit was excavated along the strike of a silicified shear zone (Figure 6-1). Some small waste rock piles are located between the pit and the north-south haul road. The total volume of these waste rock piles is estimated to be ±50 cubic yards.

6.4.2 Buckeye Mine Waste Rock Piles Geology

The Buckeye Mine waste rock piles are relatively small structures (estimated total less than 8,000 cubic yards) with WR-4 containing the largest individual volume at 3,170 cubic yards. With the exception of a minor volume of waste rock associated with the small open-cut, the piles appear to have been generated from underground mine operations that were generally limited in extent. The predominant rock type contained in the Buckeye Mine waste rock piles is biotite schist and/or biotite gneiss with lesser granodiorite. Milky-white quartz vein material containing nil to moderate concentration of FeOx is conspicuous in most of the waste rock piles. Some occasional primary pyrite was observed associated with quartz veins and zones of intense silicification in the schist/gneiss and granodiorite. With the exception of the western portion of waste rock pile WR-2 and waste rock pile WR-3, the waste rock piles generally show moderate to intense oxidation manifested by intense yellow to orange brown FeOx. Waste rock piles

WR-4 and WR-5 are the most intensely oxidized piles and both have noticeable sulfur odor. In the more intensely oxidized rock, primary rock textures are obliterated. Silicification is the dominant hydrothermal alteration present in the Buckeye Mine site area. In the more intense silicified zones, iron oxide-rich gossans are present. A representative outcrop of this material is present to the southwest of tailings pile TP-3 on the west side of the north-south haul road.

6.4.3 Buckeye Mine Waste Rock Piles Metals/pH Chemistry Results

Representative samples were collected from shovel and/or backhoe pits excavated into the waste rock piles. Individual samples were collected based on similar geologic characteristics. Twenty-seven waste rock samples and six representative composite samples were collected from waste rock piles WR-1, WR-2, WR-3, WR-4, WR-5 and the open-cut area waste rock piles (OCWR) for XRF screening. The XRF analytical results are summarized in Appendix A. The Buckeye Mine waste rock XRF concentration range results for the principal elements of interest are as follows: As (no detection – 541.6 ppm), Cr (no detection – 5,078.4 ppm), Cu (no detection – 823.2 ppm), Fe (16,588.8 – 102,963.2 ppm), Hg (no detection – 540.8 ppm), Mn (no detection – 3,619.2 ppm), Ni (no detection – 35,891.2 ppm), Mo (no detection – 29 ppm), Pb (no detection – 12,294.4 ppm), and Zn (no detection – 16,691.2 ppm). These XRF concentration ranges do not include the WR4-ORE sample results for these data were collected from a rock sample and are not representative of the finer-grained fraction of the waste rock piles.

Laboratory analytical data for the six composite samples collected from the Buckeye Mine site waste rock piles are summarized in Table 6-6. The laboratory data and chain-of-custody are contained in Appendix B. With the exception of waste rock pile WR-3 (pH = 7.8 S.U.), all of the waste rock piles are acidic with pH ranging from 2.8 to 6.5 S.U. Waste rock piles WR-4 and WR-5 are the most acidic. The mean concentrations range and the mean concentrations range relative to background mean concentrations for analytes with greater than or equal to 50 percent of the samples reporting above the method detection limit are as follows: Ag – 5.85 to 85.8 mg/Kg (>2.3x to >34.2x), As – 178.2 to 224.0 mg/Kg (19.8x to 24.9x), Ba – 23.6 to 138.2 mg/Kg (0.2x to 0.9x), Cd – 7.8 to 12.2 mg/Kg (>15.6x to >24.3x), Cr – 4.7 to 57.9 mg/Kg (0.1x to 1.8x), Cu – 171.5 to 1,024.5 mg/Kg (5.0x to 29.8x), Fe – 37,000 to 48,450 mg/Kg (2.4x to 3.2x), Hg – 2.3 to 3.9 mg/Kg (>4.6x to >7.8x), Mn – 178.9 to 1,125 mg/Kg (0.4x to 2.3x), Ni – 4.8 to 62.1 mg/Kg (0.2x to 2.7x), Pb – 823.5 to 10,375 mg/Kg (22x to 276.6x), Sb – 34.2 to 79.8 mg/Kg (>13.7x to >31.9x), and Zn – 1,300 to 2,275 mg/Kg (16.5x to 28.9x). Where applicable, the mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening concentration results with the exception of Cr Ni and Hg which when detected in XRF were significantly higher. The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Ag, As, Cd, Cu, Fe, Hg, Pb, Sb and Zn. With the exception of waste rock pile WR-3, the Buckeye Mine waste rock contains significantly elevated concentrations of a diverse suite of metal/metalloid elements.

6.4.4 Buckeye Mine Waste Rock Piles Acid-Base Accounting Results

The Buckeye Mine waste rock paste pH data indicate that most of the waste rock is acidic with the exception of WR-3 which is slightly alkaline (7.8 S.U.). Waste rock piles WR-4 and WR-5 exhibit the most intense oxidation.

Table 6-6. Laboratory Chemistry Results for Waste Rock

Sample ID	pH (SU)	Ag (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Pb (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)
Waste Rock Piles WR1, WR2 and WR3														
29-451-WR-1	6.5	9.2	328	84.3	17.9	57.9	208	50100	<1	1130	75.3	1380	<5	4080
29-451-WR-2	7.8	<5	28.4	192	2.9	57.9	135	40400	<1	1120	48.9	267	<5	470
Maximum	7.8	9.2	328	192	17.9	57.9	208	50100	<1	1130	75.3	1380	<5	4080
Minimum	6.5	<5	28.4	84.3	2.9	57.9	135	40400	<1	1120	48.9	267	<5	470
Mean	7.15	5.85	178.2	138.2	10.4	57.9	171.5	45250.0		1125.0	62.1	823.5		2275.0
No. of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Waste Rock WR4														
29-451-WR4-1	3.4	17.6	130	57.9	7.2	<5	281	38300	2.7	108	<5	1920	<5	1270
29-451-WR4-2	5.7	77.2	318	23.6	8.4	<5	416	35700	1.9	359	7.1	18100	157	1330
Maximum	5.7	77.2	318.0	57.9	8.4	<5	416	38300	2.7	359	7.1	18100	157	1330
Minimum	3.4	17.6	130.0	23.6	7.2	<5	281	35700	1.9	108	<5	1920	<5	1270
Mean	4.6	47.4	224.0	40.8	7.8		348.5	37000.0	2.3	233.5	4.8	10010.0	79.8	1300.0
No. of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Waste Rock WR5														
29-451-WR5-1	4.8	119	257	21.7	21.0	6.9	1110	51200	2.8	299	11.3	9650	56.9	3750
29-451-WR5-2	2.8	52.6	188	25.5	3.3	<5	939	45700	5.0	58.8	<5	11100	11.4	716
Maximum	4.8	119	257	25.5	21	6.9	1110	51200	5	299	11.3	11100	56.9	3750
Minimum	2.8	52.6	188	21.7	3.3	<5	939	45700	2.8	58.8	<5	9650	11.4	716
Mean	3.8	85.8	222.5	23.6	12.15	4.7	1024.5	48450	3.9	178.9	6.9	10375	34.15	2233
No. of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2	2

LEGEND

29-451-WR-1 is a composite of WR2-B; WR1-A; WR2-C; WR1-C
29-451-WR-2 is a composite of WR3-A; WR3-B; WR3-C
29-451-WR4-1 is a composite of WR4-B-0-3.7; WR4-D-0-3.2; WR4-E-0-1.3
29-451-WR4-2 is a composite of WR4-B-3.7-5.7; WR4-C-4.3-5.9
29-451-WR5-1 is a composite of WR5-A-0-1.8; WR5-C-0-2.0; WR5-E-0-2.0
29-451-WR5-2 is a composite of WR5-D-0-2.0; WR5-A-0-2.0

Note: Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation

Six representative composite waste rock samples were analyzed by the modified Sobek method for acid-base accounting (ABA) at Energy Laboratories, Inc. The laboratory analytical results are contained in Appendix B and are summarized in Table 6-4. The ABA data indicate that the total sulfur concentrations in the waste rock range from 0.02% to 3.5%. The Buckeye Mine site waste rock ABA results are variable depending on the waste rock pile. The composite samples collected from waste rock piles WR-1, WR-2 and WR-3 show positive net neutralization ranging from +30 tons per 1,000 tons (t/1000t) $CaCO_3$ to +46 t/1000t $CaCO_3$. The ABA results from waste rock piles WR-4 and WR-5 show negative net neutralization ranging from -23 t/1000t $CaCO_3$ to -40 t/1000t $CaCO_3$. The data indicate that waste rock piles WR-4 and WR-5 have the greatest potential for acid generation and the field evidence supports this assessment. These piles are the most intensely oxidized with very abundant yellow to orange brown FeOx, have the most acidic pH conditions and exhibit sulfur odor characteristic of oxidizing sulfides.

6.4.5 Buckeye Mine Waste Rock Piles TCLP Results

Splits of waste rock composite samples 29-451-WR-1, 29-451-WR4-2, and 29-451-WR5-1 were collected for metals (Ag, As, Ba, Cd, Cr, Hg, Pb, and Se) TCLP analysis at Energy Laboratories, Inc.. The waste rock TCLP laboratory analytical results are contained in Appendix B and are summarized in Table 6-5. The results indicate that lead concentrations of 80.5 mg/L and 8.3 mg/L in waste rock piles WR-4 and WR-5, respectively, exceeded the regulatory level of 5 mg/L for metal toxicity under the Resource Conservation and Recovery Act (RCRA) rules for hazardous waste classification. Lead was also detected in the leachate from the WR-1 and WR-2 composite sample, but the concentration of 1.1 mg/L is within the regulatory limit. Cadmium was detected in all of the leachates, but the concentrations were within the regulatory limit of 1 mg/L. Arsenic, barium, chromium, mercury, selenium and silver were not detected in TCLP analyses above the method detection limit.

6.5 BRANDON MILL WASTE AREA

Another former millsite located in the Buckeye Mine project area is the Brandon Mill. This site is also referred to as the Buckeye Mill in the site cultural resources assessment report, (Frontier Historical Consultants, 2003). The former Brandon mill is located south of Mill Creek road (Figure 6-3). A rock foundation wall, 30 feet long by 8 feet high, on the hillside marks the former mill building site. Abundant debris is associated with this site, much of it related to more modern operations. An inventory of the debris in the Brandon millsite area is presented in Table 6-7.

The former millsite surface area is composed predominantly of native soils consisting of sand and gravel with cobbles. There are some obvious pockets of mine tailings and crushed ore principally in the former mill building area. The tailings are most likely spillage and residual tailings washed out of the mill building during operations. Much of the near surface native soil materials have been impacted by mill operations. Based on oxidation evidence and XRF screening analysis, much of the near surface (≤2 feet) native soils in the former mill area have been impacted former operations. Two likely sources of contaminants impacting the near surface native soils are tailings spills and particulate emissions from crushing operations.

6.5.1 Brandon Mill Impacted Soil and Waste Volume Estimates

A detailed topographic survey was completed on the Brandon mill site area (Figure 6-3).

TABLE 6-7 INVENTORY OF DEBRIS ASSOCIATED WITH THE BRANDON MILLSITE

Item Description	Quantity	Comment(s)
Lead-Acid Batteries	16	Automotive batteries
Vehicle Tires, various sizes	21	
55-gallon Steel Drums	16	2 drums - estimate. ¼ full of liquid
40-gallon Steel Drums	4	Empty
2.5 gallon Steel Pail	1	Used oil + solids, no cover
Fuel Storage Tank (6 ft. long by 3 feet diameter)	1	Empty
Fuel Oil Tank (5.5 feet long by 3.5 feet high)	1	Empty
Propane Bottle – 30 gallon?	1	
Steel Cable Reel (¾ inch diameter) and one smaller steel cable reel	2	
Large Conveyor Belt Motor – 5.5 inch diameter shaft	1	
Dilapidated House Trailers (approximately 50 feet long by 10 feet wide)	5	Abundant household goods, clothes, paper, etc. and mice/rat feces
Dilapidated Travel Trailer (approximately 20 feet long by 5 feet wide)	1	
Wooden Rack Trailer	1	Full of junk including kitchen stove
Large, steel, ~8 feet diameter unknown devices with screens; likely mill processing equipment	4	
Other Miscellaneous Wood/Metal Debris	Estimate ±3 10 cubic yard truck loads	

The survey data were used along with nineteen shovel pits to calculate a volume estimate for the impacted soils and wastes (includes tailings and crushed ore) identified in the Brandon millsite area. The volume was calculated using an Eagle Point surface model of the impacted millsite surface and the projected native surface below the site.

The projected native surface and depth contours are shown on Figure 6-4. Table 6-2 summarizes the volume calculation result for the Brandon Mill area. The estimated volume of the impacted soils and identified mill wastes is 2,750 cubic yards. Shovel pits and XRF screening analysis indicated a maximum 2 feet depth for the impacted soils in this area. The volume estimate makes provision for the extraction of the upper 2 feet of soils in the millsite area. The plan area is 0.98 acres and the average and maximum impacted soil depths are 1.7 feet and 2.0 feet, respectively.

6.5.2 Brandon Mill Impacted Soil and Waste Geology

The native soils located in the Brandon Mill area are typically chocolate brown, silty sand with variable gravel and cobbles. A review of the test pit logs (Appendix C) and XRF screening results (Appendix A) illustrate the difficulty in differentiating impacted native soils from non-impacted soils. When present, the field characteristics that support impacted native soils include pockets of light tan, silty sand tailings or variable yellow to orange brown iron oxidation.

Tailings occur in larger pockets, especially in the immediate area of the old mill site. This material is typical light tan, silty sand with variable FeOx. Occasional greenish gray clayey silt tailings slime is present as a thin layer in the silty sands. Two small areas of crushed and coarse ground ore are located on the old mill foundation bench on the side of the hill. This material consists of both primary and oxidized ore. Cubic pyrite is a significant sulfide mineral component in the non-oxidized, greenish gray coarse sand ore. The strongly oxidized ore is typically a yellow FeOx-rich rock with a strong sulfur odor.

6.5.3 Brandon Mill Waste Metals/pH Chemistry Results

Representative samples were collected from shovel pits excavated into the waste rock piles. Individual samples were collected based on similar geologic characteristics. Twenty-three soil and waste rock samples and three representative composite samples were collected from the Brandon Mill area for XRF screening. The XRF analytical results are summarized in Appendix A. The Brandon Mill soil and waste rock XRF concentration range results for the principal elements of interest are as follows: As (no detection – 1,480 ppm), Cu (no detection – 1,029.6 ppm), Cr (726 – 8,307.2 ppm), Fe (31,692.8 – 180,940.8 ppm), Hg (no detection – 1,109.6 ppm), Mn (no detection – 7,104 ppm), Mo (no detection – 35 ppm), Ni (no detection – 55,552 ppm), Pb (79.6 – 38,195.2 ppm), and Zn (306.6 – 8,588.8 ppm). In the XRF results, Pb and Zn are the most useful elements for determining impacted native soils. The XRF and laboratory results for these elements generally show strong correlation with correlation coefficients of 0.93 and 0.98, respectively (Appendix B).

Laboratory analytical data for the three representative composite samples collected from the Brandon Mill area are summarized in Table 6-1. The laboratory data and chain-of-custody are contained in Appendix B. The impacted soils and waste rock pH are moderately to strongly acidic ranging from 2.1 to 6.5 S.U. The mean concentrations and the mean concentrations relative to background mean concentrations for analytes are as follows: Ag – 108.5 mg/Kg

(>43.4x), As – 353.3 mg/Kg (39.3x), Ba – 99.3 mg/Kg (0.7x), Cd – 10.6 mg/Kg (>21.2x), Cr – 21.4 mg/Kg (0.7x), Cu – 742.5 mg/Kg (21.6x), Fe – 51,900 mg/Kg (3.4x), Hg - 1.5 mg/Kg (>3.0x), Mn – 168.7 mg/Kg (0.3x), Ni – 16.1 mg/Kg (0.7x), Pb – 18,435 mg/Kg (491.6x), Sb – 18.1 mg/Kg (>7.2x), and Zn – 2,045 mg/Kg (26x). Total cyanide was not detected above the lower detection limit of 0.5 mg/Kg. For the elements that have both XRF and laboratory results, the mean concentrations from the laboratory quantitative analyses on representative composite samples generally corroborate the XRF screening concentration results with the exception of Cr, Hg, Mn, and Ni which are significantly higher concentrations in the XRF method.

The analytes with an average concentration greater than or equal to three times the average background soil concentration include: Ag, As, Cd, Cu, Fe, Hg, Pb, Sb and Zn. The near surface soils in the Brandon Mill area are impacted by a diverse suite of metal/metalloid elements typical of polymetallic base metal mineralization.

6.5.4 Brandon Mill Waste Acid–Base Accounting Results

The Brandon Mill impacted soils and waste rock paste pH data indicate that most of the material is moderately to strongly acidic. The waste materials consist of impacted soils with lesser tailings and partially processed ore. The presence of acid pH conditions indicates that oxidation is causing some acid generation in the wastes.

Three representative composite waste rock samples and a duplicate sample were analyzed by the modified Sobek method for acid-base accounting (ABA) at Energy Laboratories, Inc. The laboratory analytical results are contained in Appendix B and are summarized in Table 6-4. The ABA data indicate that the total sulfur concentrations are elevated with concentrations ranging from 1.7% to 7.6%. The composite samples show negative net neutralization ranging from -142 t/1000t $CaCO_3$ to -0.5 t/1000t $CaCO_3$. The ABA results support the fact that the waste materials in the Brandon Mill area are acid generating.

6.5.5 Brandon Mill Waste TCLP Results

One representative composite sample of obvious oxidized tailings were collected for metals (Ag, As, Ba, Cd, Cr, Hg, Pb, and Se) TCLP analysis at Energy Laboratories, Inc. The waste rock TCLP laboratory analytical results are contained in Appendix B and are summarized in Table 6-5. The results indicate that the lead concentration (12.1 mg/L) in the oxidized tailings in the Brandon Mill area exceeded the regulatory level of 5 mg/L for metal toxicity under the Resource Conservation and Recovery Act (RCRA) rules for hazardous waste classification. Cadmium was the only other analyte detected in the leachate but the concentration (0.3 mg/L) was within the regulatory limits of 1 mg/L.

7.0 SUMMARY OF TAILINGS AND WASTE ROCK CHARACTERIZATION RESULTS

The Buckeye Mine project area contains five mill tailings piles, five waste rock piles and the Brandon Mill site wastes as the principal mine/mill waste sources. Table 7-1 provides a summary of the volume and key chemistry data results for mine/mill wastes identified in the

Table 7-1. Buckeye Mine and Brandon Mill Waste Summary

Waste Source	Waste Volume CY	Parameters with Elevated Concentrations[1]	Acid-Base Accounting NNP (t/1000t $CaCO_3$)	TCLP Exceedance
Buckeye Mine Tailings				
TP-1	4,000	Ag, As, Cd, Cu, Pb, Zn	+21 to +116	
TP-2	2,260	Cd, Zn	+128 to +129	NA
TP-3	3,150	Ag, As, Cd, Cu, Pb, Zn	+35 to +167	Pb
TP-4	3,170	Ag, As, Cd, Cu, Hg, Pb, Sb, Zn	-108 to +106	Pb
TP-5	900	Ag, As, Cd, Cu, Hg, Pb, Zn	-1 to -2	
Buckeye Mine Waste Rock				
WR-1	180	Ag, As, Cd, Cu, Fe, Ni, Pb, Zn	+30	
WR-2	1,269	Ag, As, Cd, Cu, Fe, Ni, Pb, Zn	+30	
WR-3	220	As, Cd, Cu, Pb, Zn	+46	NA
WR-4 (including Gossan area)	3,890	Ag, As, Cd, Cu, Hg, Pb, Sb, Zn	-20 to -40	Pb
WR-5	2,280	Ag, As, Cd, Cu, Fe, Hg, Pb, Sb, Zn	-30 to -40	Pb
Brandon Mill Wastes and Impacted Soils	2,750	Ag, As, Cd, Cu, Fe, Pb, Sb, Zn	-0.5 to -100	Pb

Note: 1 - Elevated elements are those with mean concentrations greater than 3x background soil mean concentration
NA = Not Analyzed

project area. The total waste volume is 24,069 cubic yards and individual waste source volumes range from 180 to 4,000 cubic yards. The tailings, waste rock and Brandon Mill wastes are significantly elevated above background soil concentrations for multiple elements. Total cyanide was not detected in any of the Buckeye Mine site wastes.

Acid-base accounting results indicate that tailings piles TP-1, TP-2 and TP-3 and waste rock piles WR-1, WR-2 and WR-3 have positive net neutralization potentials with the mill tailings ranging from +21 to +167 t/1000t $CaCO_3$ and the waste rock ranging from +30 to +46 t/1000t $CaCO_3$. The wastes showing acid-base accounting negative net neutralization potentials (-0.5 to -142 t/1000t $CaCO_3$) include tailings piles TP-4 and TP-5, waste rock piles WR-4 and WR-5 and the tailings associated with the Brandon Mill area.

Although mine/mill wastes are exempted from hazardous waste regulation because of the Bevill Amendment, RCRA TCLP analyses were performed to evaluate if the wastes have leachable concentrations of RCRA metals. Lead concentrations failed RCRA TCLP analysis in tailings piles TP-3 and TP-4, waste rock piles WR-4 and WR-5 and the tailings associated with the Brandon Mill area. The data suggest that much of the Pb in these waste sources occurs in an oxidized state making it more leachable.

X-ray fluorescence spectrometry (XRF) screening results for Pb and Zn suggest that some of the native soils beneath the tailings and waste rock have been impacted by leaching of these metals. The near surface (0-2 feet depth) native soils in the Brandon Mill area are also impacted over much of the former mill site. In the areas where native soils exhibit elevated XRF Zn concentrations, Cd is also likely present for this element has been shown to be positively correlated with Zn in the quantitative laboratory waste results.

8.0 SURFACE WATER AND GROUNDWATER CHARACTERIZATION

The Buckeye Mine site is located in the Mill Creek drainage, a tributary to the Ruby River. The site is located approximately 11.3 miles above the confluence of Mill Creek and the Ruby River. Tailings TP-4 and waste rock WR-5 piles are adjacent to the banks of Mill Creek. The Brandon Mill and tailings pile TP-5 are located on the south side of Mill Creek road. Tailings piles TP-1 through TP-3 and waste rock piles WR-1 through WR-4 are located above the Mill Creek floodplain near an unnamed, ephemeral tributary. Figure 1-1 shows the Buckeye Mine site and its relationship to the Mill Creek drainage.

8.1 SURFACE WATER SAMPLING RESULTS

Three surface water samples were collected to assess potential impacts from the mine/mill waste sources contained in the Buckeye Mine site. Surface water samples, 29-451-SW1 and 29-451-SW2, were collected from Mill Creek to assess potential surface water impact from the Buckeye mine/mill waste sources (Figure 6-3). The background sample, SW1, was collected approximately 100 feet upstream from where the former bridge crossed Mill Creek to allow road access from the mine to the mill area. The sample is upstream of the waste sources associated with the Buckeye Mine site. Sample site SW2 is located downstream of the Buckeye Mine waste sources and is approximately 20 feet downstream of tailings pile TP-4.

Surface water sample 29-451-SW3 was collected from a spring located approximately 30 to 40 feet to the west of the gravel road approximately 0.2 miles north of the gate into the northern portion of the Buckeye Mine site (Figure 1-1).

The surface water samples were collected on July 29, 2004 according to standard protocols as described in the Field Sampling Plan for the Buckeye Mine (DEQ-MWCB/Olympus, 2004a). At each sample site, stream flow was estimated and field parameters including pH and specific conductivity were measured. Surface water samples were analyzed at Energy Laboratories, Inc. for pH, total dissolved solids, sulfate, chloride, nitrate + nitrite as N, hardness and a fifteen element suite including Ag, As, Ba, Ca, Cd, Cr, Cu, Fe, Hg, Mg, Mn, Ni, Pb, Sb and Zn.

The laboratory analytical results and chain-of-custody are contained in Appendix B and summarized in Table 8-1. The surface water chemistry results should represent low flow conditions as they were collected after the snowmelt runoff and not during a stormwater runoff event. The surface water results indicate that Ag, As, Ba, Cd, Cr, Hg, Ni, Pb, Sb and Zn were not detected in any of the surface water samples collected from Mill Creek. For low flow conditions, the data indicate that there is very little impact to the surface water quality and no exceedance of Federal or Montana surface water quality standards in Mill Creek near the site. However, field observations indicate that during snowmelt and/or stormwater runoff events, tailings and waste rock sediment are being eroded into Mill Creek from TP-4 and WR-5, respectively. The analytical results from the discharging spring were similar to the metal/metalloid results from Mill Creek with the exception of the detection of a low concentration of Mn (40 mg/L) and the elevated concentration of total dissolved solids (489 mg/L). The water chemistry results for the spring did not exceed Federal or Montana surface water quality standards.

8.2 GROUNDWATER CHEMISTRY RESULTS

Except for a well casing that was discovered in the Brandon Mill area during site characterization fieldwork, no groundwater wells occur in the immediate Buckeye Mine site. Two private wells are located just outside the project area boundary near tailings piles TP-4 and TP-5. The aerial orthophotograph presented in Figure 8-1 shows the location of the residences and the general area of the mine/mill wastes identified at the Buckeye Mine site.

As part of the site characterization work on the Buckeye Mine site, the two private, residential wells near mill tailings waste areas were sampled on July 29, 2004 for water quality. In both cases, the owners of the wells were notified and access was granted for water quality sampling. The residential wells are located at the following street addresses: 241 and 242 Mill Creek Road. The well depths are reported by Mr. Garner to be ±30 feet (241 Mill Creek Road) and 27 feet (242 Mill Creek Road) and the wells are housed in small wooden buildings adjacent to the residences. A search of the wells located in Section 19, Township 4 South and Range 4 West that are registered in the Montana Bureau of Mines and Geology Groundwater Information Center database (Appendix D) was not successful in identifying these wells. It may be possible that they were drilled and registered by a previous owner. The following is the contact information for these residences:

TABLE 8-1. Laboratory Chemistry Results For Surface Water, Groundwater and Spring Discharge

Total Recoverable Metals

Sample ID	Ag (ug/L)	As (ug/L)	Ba (ug/L)	Ca (mg/L)	Cd (ug/L)	Cr (ug/L)	Cu (ug/L)	Fe (ug/L)	Hg (ug/L)
29-451-SW1	<5	<3	<100	21	<1	<10	<10	70	<0.6
29-451-SW2	<5	<3	<100	20	<1	<10	<10	80	<0.6
29-451-SW3	<5	<3	<100	89	<1	<10	<10	40	<0.6
29-451-GW1	<5	<3	<100	46	7	<10	20	200	<0.6
25-179-GW2	<5	<3	<100	60	<1	<10	<10	<30	<0.6
Federal MCL	100	50	2000	-	5	-	1000	300	2
Montana HHS - SW	100	18	2000	-	5	-	1300	300	0.05
Montana HHS - GW**	100	20	2000	-	5	-	1300	300	2
Chronic ALS*	-	150	-	-	0.27	-	9.33	1000	0.91
Acute ALS*	4.06	340	-	-	2.13	-	13.99	-	1.7

Sample ID	Mg (mg/L)	Mn (ug/L)	Ni (ug/L)	Pb (ug/L)	Sb (ug/L)	Zn (ug/L)	Total CN (ug/L)
29-451-SW1	5.5	<10	<10	<2	<5	<10	NA
29-451-SW2	4.9	<10	<10	<2	<5	<10	NA
29-451-SW3	35	40	<10	<2	<5	<10	NA
29-451-GW1	16	30	<10	<2	<5	1310	<5
25-179-GW2	21	<10	<10	<2	<5	90	<5
Federal MCL	-	50	100	15	6	5000	200
Montana HHS - SW	-	50	100	15	6	2000	200
Montana HHS - GW**	-	50	100	15	6	2000	200
Chronic ALS*	-	-	52.2	3.2	-	119.8	5.2
Acute ALS*	-	-	469.2	81.6	-	119.8	22

Surface Water Wet Chemistry Results

Sample ID	pH (SU)	TDS (mg/L)	Sulfate (mg/L)	Chloride (mg/L)	Nitrate + Nitrite as N (mg/L)	Hardness as $CaCO_3$ (mg/L)
29-451-SW1	7.9	85	5.4	1.8	<0.05	74
29-451-SW2	7.9	83	6.8	1.7	<0.05	69
29-451-SW3	8.0	489	180	6.7	<0.05	364
29-451-GW1	7.3	246	70	5.0	0.37	183
25-179-GW2	7.5	316	140	6.0	0.71	235
Federal MCL	6.5-8.5	500	250	250	10	
Montana HHS						

Surface Water Field Measurements

Sample ID	pH (SU)	SC (mS)	Stream Flow (cfs)
29-451-SW1	7.60	0.145	29
29-451-SW2	8.14	0.10	25
29-451-SW3	7.77	0.61	~1-2 gpm
29-451-GW1	7.14	0.29	-
25-179-GW2	7.36	0.38	-

NA = Not analyzed; * = Based on hardness of 100 mg/L $CaCO_3$ equivalent; ** = Montana HHS for groundwater based on dissolved metal concentration only

LEGEND

29-451-SW1 collected 7/29/04 from Mill Creek approximately 100 feet upstream of point where former bridge crossed creek (UTM coord: 411281E; 5035381N)

29-451-SW2 collected 7/29/04 from Mill Creek approximately 20 feet downstream of TP4 tailings area (UTM coord: 411137E; 5035380N)

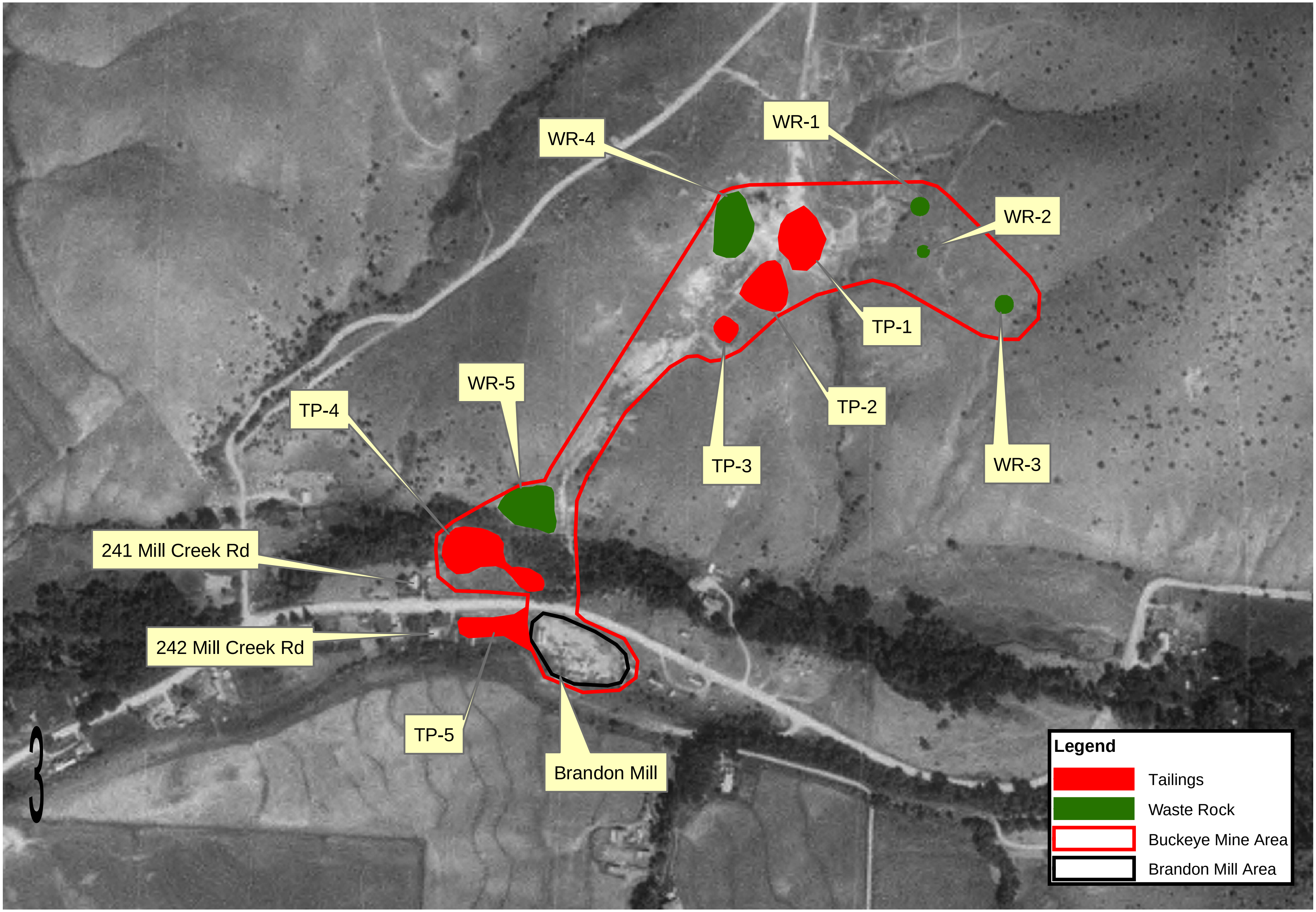
29-451-SW3 collected 7/29/04 from spring located ~30'-40' to west of gravel road approximately 0.2 miles north of gate into northern portion of Buckeye Mine (UTM coord: 411409E; 5036015N)

29-451-GW1 collected 7/29/04 from kitchen faucet of residence located immediately to the west of tailings pile TP4

29-451-GW2 collected 7/29/04 from bleeder valve located near well head in well pumphouse at residence immediately to the west of tailings pile TP5

Federal MCL = Federal primary and secondary maximum contaminant level based on total recoverable metal concentration; Drinking Water Standards and Health Advisories, EPA October 1996

Montana HHS = Montana human health standard based on dissolved metal concentration; Circular WQB-7 Montana Numeric Water Quality Standards, January 2002



Olympus Technical Services, Inc.

0 400 800 Feet

Figure 8-1
Aerial Photograph of the Buckeye
Mine Area Showing Residences

Angela McCarthy (Renter) 241 Mill Creek Road Sheridan, MT 59749 Rich Lewis (owner) – Sheridan, MT	Bill and Kaiti Garner (Owners) 242 Mill Creek Road Sheridan, MT 59749

The well house was locked and the renter at 241 Mill Creek Road did not have a key. She contacted the owner of the residence and he said to collect the water sample from an outlet in the house. The water samples (29-451-GW1) were collected from the kitchen sink faucet at the 241 Mill Creek Road site after letting the water discharge for a period of time prior to sampling. The water samples (29-451-GW2) at the Garner residence (242 Mill Creek Road) were collected from a bleeder valve faucet in the well house near the well head. At the latter location, the well water discharges through a filter (reportedly for particulates only) at the well head prior to the faucet discharge point.

The water samples were analyzed at Energy Laboratories, Inc. for the following parameters: Total recoverable metals (Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb, and Zn), total cyanide, pH, total dissolved solids, sulfate, chloride, nitrate + nitrite as N and hardness as $CaCO_3$. The analytical results for water samples 29-451-GW1 and 29-451-GW2 are summarized in Table 8-1 and the laboratory analytical reports and chain-of-custody are contained in Appendix B.

The analytical results indicate that cadmium (Cd), copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) were detected in the 241 Mill Creek Road well and only zinc (Zn) was detected in the 242 Mill Creek Road well. The total recoverable Cd concentration of 0.007 mg/L detected in the 241 Mill Creek Road exceeds the Federal safe drinking water standard maximum contaminant level (MCL) of 0.005 mg/L. The other metals are within Federal drinking water standards. Total cyanide was not detected above the lower detection limit of 5 µg/L. The somewhat diverse metal suite detected in the 241 Mill Creek Road well is not unlike that detected in the chemistry results for the Buckeye Mine site waste sources, with the exception of lead (Pb). Lead is the one of the principal contaminants identified in the Buckeye Mine site waste sources. Lead mobility is generally limited in natural waters due to the fact that it readily undergoes cation exchange with clays in soils. Field screening XRF results seem to corroborate this in that Pb is a significant contaminant source in the Buckeye Mine site wastes, but exhibits very limited mobility into the native soils analyzed beneath the wastes. Zinc, however, does show mobility and cadmium has been shown to be geochemically correlated with Zn in the quantitative laboratory analyses of the wastes. At this point, we know nothing about the plumbing system in the home. Piping in the home, in some cases, can contribute metal contamination of water supplies. A common source for Zn and Cd is galvanized pipes.

9.0 STREAM SEDIMENT CHARACTERIZATION

Two stream sediment samples were collected at the same locations as the surface water samples from Mill Creek. Stream sediment samples, 29-451-SE1 and 29-451-SE2, were collected from Mill Creek to assess potential sediment impact from the Buckeye mine/mill waste sources (Figure 6-3). The background sample, SE1, was collected approximately 100 feet upstream from where the former bridge crossed Mill Creek to allow road access from the mine to the mill area. The sample is upstream of the waste sources associated with the Buckeye Mine site. Stream sediment sample site SE2 is located downstream of the Buckeye Mine waste sources and is approximately 20 feet downstream of tailings pile TP-4.

The stream sediment samples were analyzed at Energy Laboratories, Inc. for the following parameters: Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb, Zn and pH. The stream sediment analytical results are summarized in Table 9-1 and the laboratory analytical reports and chain-of-custody are contained in Appendix B.

No metal/metalloid in the stream sediments is greater than three times the mean background soil. The only metals that show an increase in concentration from the upstream to the downstream site relative to the Buckeye Mine area are Ba (1.0x), Cr (1.1x), Ni (1.1x), Pb (3.6x), and Zn (1.3x). Although the overall concentrations of these metals are low, the results do suggest some metal loading from waste sources to Mill Creek. Metal loading is likely related to stormwater/snowmelt runoff events as discussed earlier.

Four stream sediment samples were collected in 1976 in the general area of the Buckeye Mine site as part of the National Uranium Resource Evaluation (NURE) program (USGS, 2001). These samples were collected from tributaries of Mill Creek. The location of the stream sediment samples is presented in Figure 2-5 and the analytical results are summarized in Table 2-4. Although none of the stream sediment samples were collected in the tributary drainage where the Buckeye Mine site is located, the samples are representative of the stream sediment geochemistry for tributaries draining areas upgradient of the site. The range of concentrations reported for the elements of interest are as follows: Ag (<5 ppm), As (not analyzed), Ba (<264-539 ppm), Cd (<5-5 ppm), Co (9.8-27.3 ppm), Cr (68-87 ppm), Cu (18-63 ppm), Fe (13,560-51,570 ppm), Hg (not analyzed), Mn (418-2,865 ppm), Ni (17-64 ppm), Pb (<5-26 ppm), Sb (<3 ppm), and Zn (91-159 ppm).

10.0 ASSESSMENT OF AIRBORNE PARTICULATE EMISSIONS

The principal waste sources in the Buckeye Mine site are mill tailings and waste rock piles. Waste rock pile gradations are typically coarse grained containing abundant rock material. These waste sources thus contain lesser fine sediment that could be a source for airborne particulate emissions. The mill tailings typically are very fine grained to fine grained and consist of silt, sand and clay. The near surface tailings may exhibit floury textures which when disturbed create dust emissions. Although some of the tailings have vegetation, there are significant areas of exposed tailings with little to no vegetation cover. Although the volume of tailings located in the Brandon Mill area is low, fine grained tailings has mixed with near surface native soils and impacted these soils with elevated metal/metalloid concentrations. Laboratory chemistry results for composite tailings indicate that they contain a polymetallic suite. Laboratory analyses indicate that a number of elements of environmental concern may be significantly elevated above background soil concentrations in the tailings and these include Ag, As, Cd, Cu, Hg, Pb, Sb and Zn. The range of concentrations for these parameters in each of tailings piles is summarized in Table 10-1. Although there is some controlled vehicle access because of fencing and gates for all of the tailings piles except TP-5, the tailings are generally accessible via foot traffic. Tailings piles TP-4, TP-5 and the Brandon Mill area are generally barren of vegetation and contain the most elevated concentrations of potential airborne contaminants. These waste sources are also located nearest to residential areas.

Table 9-1. Laboratory Chemistry Results for Stream Sediments

Sample ID	pH (SU)	Ag (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Pb (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)
29-451-SE1	6.9	<5	<5	20.9	<1	24.6	32.9	10300	<5	<1	202	16.5	<5	15.3
29-451-SE2	6.9	<5	<5	21.3	<1	26.0	14.5	8570	8.9	<1	165	17.7	<5	20.0
Maximum	6.9	<5	<5	21	<1	26	33	10300	8.9	<1	202	18	<5	20
Minimum	6.9	<5	<5	20.9	<1	24.6	14.5	8570.0	<5	<1	165.0	16.5	<5	15.3
Mean	6.9			21.1		25.3	23.7	9435.0	5.7		183.5	17.1		17.7
n	2	2	2	2	2	2	2	2	1	2	2	2	2	2

LEGEND

29-451-SE1 collected 7/29/04 from Mill Creek approximately 100 feet upstream of point where former bridge crossed creek (UTM coord: 411281E; 5035381N)
29-451-SE2 collected 7/29/04 from Mill Creek approximately 20 feet downstream of TP4 tailings area (UTM coord: 411137E; 5035380N)

Note: Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation

Table 10-1. Summary of the Range of Metal/Metalloid Concentrations in Mill Tailings

	Range of Concentration (mg/Kg)							
Tailings Area	**Ag**	**As**	**Cd**	**Cu**	**Hg**	**Pb**	**Sb**	**Zn**
TP-1	<5-15.4	45.1-206	2.9-9.7	94.1-522	<1	281-1,990	<5-13.4	494-1,920
TP-2	<5	6.5-9.7	1.4-1.6	54.4-62.4	<1	97-109	<5	328-394
TP-3	<5-59.7	5.6-508	1.1-6.9	40.2-1,430	<1	86.5-5,510	<5	189-412
TP-4	15.5-60.1	143-338	23.1-79.3	472-1,980	<1-3.3	1,640-7,750	11.5-49.9	3,500-12,500
TP-5	11.8-22.7	106-222	6.6-15.4	287-458	<1-2.5	1,440-2,900	<5-11.7	1,070-2,850
Brandon Mill Area	49.9-268	295-455	5.0-16.8	505-961	<1-2.6	7,240-43,400	12.8-32.4	1,010-2,830

11.0 ASSESSMENT OF PHYSICAL HAZARDS

The physical hazards in the Buckeye Mine site are limited. There appears to have been much work done to eliminate physical hazards in much of the northern portion of the Buckeye Mine site since the cultural resources and inventory assessment completed in 2003 (Frontier Historical Consultants, 2003). Most of the open mine workings described in this report are no longer accessible because they have been backfilled. The two mill buildings have been dismantled and the only structures remaining in the former mill area in the northern portion of the project are two small wooden buildings with metal siding, a wooden headframe with ore bin, wooden loading platform, wooden stairway, concrete pad and minor miscellaneous metal and wood debris. The buildings and headframe are generally structurally sound and do not appear to be in danger of collapse. The wooden stairway is a physical hazard due to the structurally integrity. There is a spur powerline and transformer which likely provided power to the former mill and this is located near the wooden headframe. It is unknown whether the power has been cutoff or the transformer contains polychlorinated biphenols (PCBs) oil.

All of the adits associated with the waste rock piles are collapsed and non-accessible with the exception of an open hole into the underground near the gossan outcrop area and an open adit with wooden door located approximately 200 feet northeast of waste rock pile WR-5. These are potential physical hazards for they provide access into the former underground mine workings in these areas.

The former Brandon Mill area is evidenced by the remaining rock foundation walls on the side of the hill. The main foundation wall in the former mill area is approximately 30 feet long and 8 feet high and could constitute a fall hazard. The five abandoned house trailers are dilapidated and contain much broken glass and nails constituting physical hazards. Probably the greatest hazard associated with these structures is biological due to the potential for hanta virus. These dilapidated trailers contain abundant mice feces. The presence of numerous lead-acid batteries and two 55-gallon drums, partially filled with unknown liquids, present potential chemical hazards. Although the two fuel tanks and a propane bottle located in the Brandon Mill appear to be empty, none of these containers were accessed to evaluate whether residual products are present.

12.0 SUMMARY OF CONTAMINANT EXPOSURE PATHWAYS

Based on the detailed site characterization results, a preliminary evaluation can be made on exposure pathways. The subject of contaminant exposure and risk assessment will be addressed in the Expanded Engineering Evaluation/Cost Analysis report for the Buckeye Mine project which will be completed at a later date. The four exposure pathways, i.e., direct contact, surface water, groundwater, and air, were evaluated to assess the contribution of each route to the overall site human health and environmental threat.

12.1 DIRECT CONTACT

Direct contact with mill tailings sediment presents one of the highest exposure pathways for human and ecological receptors at the site. Significant areas of exposed tailings are located in all of the tailings piles TP-1, TP-2, TP-3, TP-4 and TP-5. These tailings contain elevated levels of Ag, As, Cd, Cu, Hg, Pb, Sb and Zn, and are generally readily accessible via foot traffic. The other area with lesser tailings, but impacted near surface soils is the former Brandon Mill. This area is readily accessible by both vehicle and foot traffic and there is a risk of direct exposure to the same potential contaminant suite. Exposed mill tailings increase the potential for off-site migration of contaminants and the possibility for inhalation or ingestion of contaminants by both human and wildlife receptor populations. The mine waste rock piles also contain elevated metals, but due to the overall coarse gradation of these sources, the potential for direct contact and impact from inhalation or ingestion are lessened.

12.2 SURFACE WATER

Mill Creek is the only perennial stream located within the Buckeye Mine site. Tailings pile TP-4 and waste rock pile, WR-5, are located adjacent to this waterway. Field evidence indicates that eroded sediments from these waste sources likely are deposited in Mill Creek during stormwater/snowmelt runoff events. Erosion of mill tailings or fine-grained waste rock sediment is a problem for surface water quality because of turbidity and metal loading into the stream bed, especially Cd, Cu, Pb, Hg and Zn. These elements are known to have significant environmental impacts to aquatic life and fish.

Surface water quality sampling, however, did not indicate any impact to surface water quality during low flow conditions. No Federal or Montana surface water quality standards were exceeded during the low flow sampling event. Chemical analyses of these two waste sources indicate that they contain some of the highest concentrations of potential contaminants in the Buckeye Mine site. In addition, both waste sources are acid generating thereby increasing the potential for contaminant solubility for many of the elevated metals.

12.3 GROUNDWATER

Groundwater in the drainage basin occurs at depth in fractured metasediment and or igneous intrusive bedrock and in the shallow alluvium of the unnamed tributary stream of Mill Creek and Mill Creek along with their floodplains. None of the test pits excavated in the northern portion of the Buckeye Mine site intersected shallow groundwater or any significant moisture content in the sediments. Based on the vegetation pattern, there is some seepage associated with a closed adit located in the waste rock pile WR-2 area.

Groundwater appears to be relatively shallow at least in the southern portion of the Buckeye Mine site. Residential wells located in this area are generally less than 50 feet deep and are likely producing water from the shallow aquifer. Groundwater sampling was conducted on two of the nearest private wells to the Buckeye Mine site and the water quality results were varied. The analytical results indicate that Cd, Cu, Fe, Mn and Zn were detected in the well located nearest to the TP-4 tailings pile and only Zn was detected in the other well adjacent to the TP-5 tailings area. The total recoverable Cd concentration of 0.007 mg/L detected in the well near TP-4 exceeds the Federal safe drinking water standard maximum contaminant level (MCL) of 0.005 mg/L. The metals detected in the domestic water wells have also been shown to be elevated in the nearby tailings waste sources.

Based on the proximity of some of the Buckeye Mine waste sources to shallow domestic wells and the limited chemistry work conducted to date on selected shallow wells, groundwater could be an exposure pathway for metals when the shallow aquifer is used for domestic or livestock drinking water wells. The presence of metals in the shallow groundwater enhances the potential for ingestion in human and animal receptors.

12.4 AIR

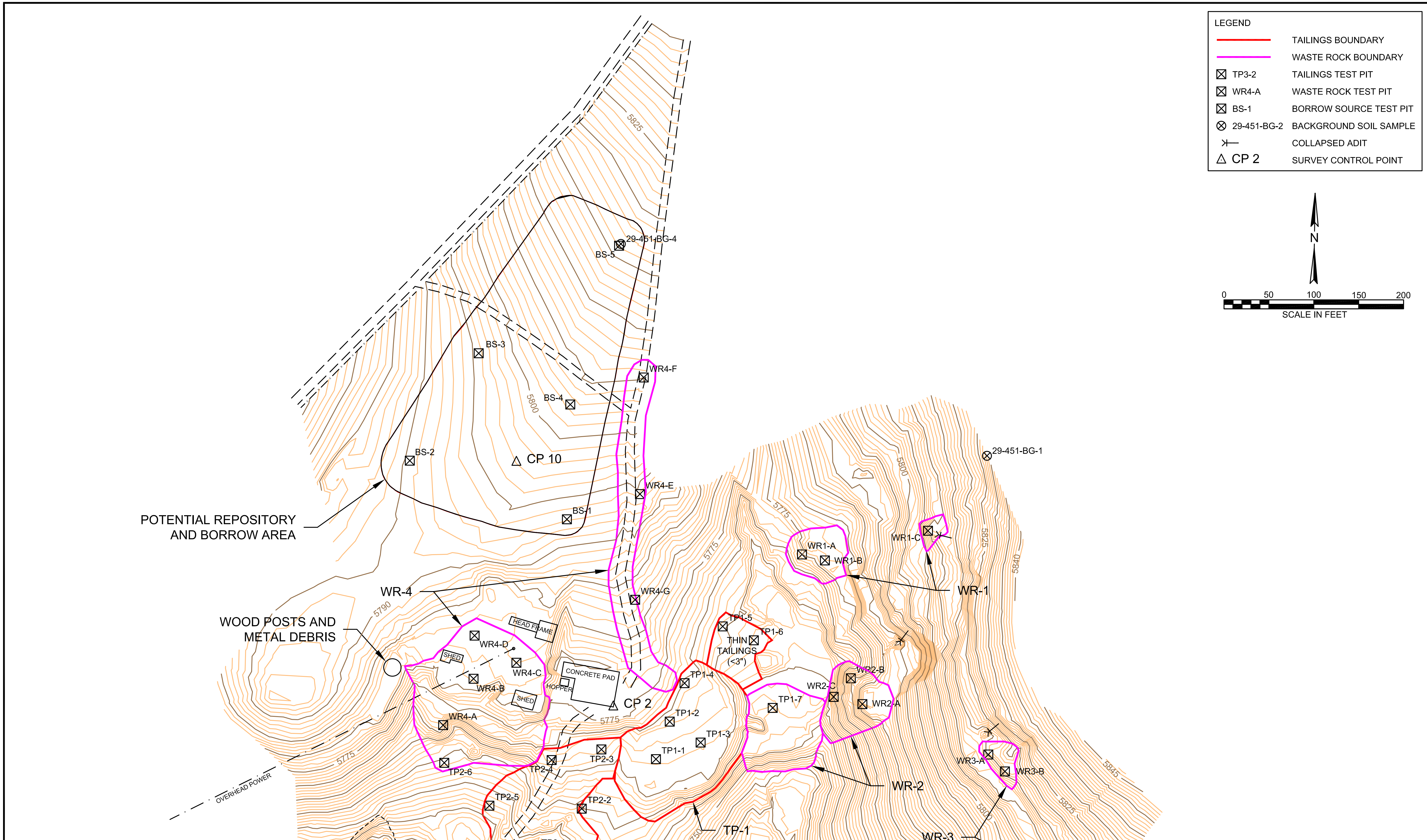
The principal waste sources in the Buckeye Mine project area are the mill tailings and waste rock piles. Waste rock pile gradations are typically coarse grained containing abundant rock material. These waste sources thus contain lesser fine sediment that could be a source for airborne particulate emissions. The mill tailings typically are very fine grained to fine grained and consist of silt, sand and clay. The near surface tailings commonly exhibit floury textures which when disturbed create dust emissions.

Exposed mill tailings increase the potential for metal contaminants to be emitted as airborne particulates. Air could be an exposure pathway for particulate inhalation. Chemistry results for composite tailings samples indicate that the Buckeye Mine tailings contain elevated levels of Ag, As, Cd, Cu, Hg, Pb, Sb and Zn and these elements would be the principal contaminants of concern for airborne particulate emissions. The Brandon Mill site has widespread near surface native soil impacts from the same elevated metal/metalloid suite and this area could also be a source of particulate emissions especially since it is readily accessible to vehicular traffic.

13.0 POTENTIAL BORROW SOURCE INVESTIGATION

Viable cover soil borrow sources do not appear to be an issue in the Buckeye Mine site area. A potential borrow source area was evaluated in the northern portion of the site. This area is nearly bisected by the northwest-southeast access road into the northern-most mill site associated with the Buckeye Mine (Figure 13-1). Five backhoe test pits (BS-1 through BS-5) were excavated to assess the potential cover soil borrow source. The test pit logs are presented in Appendix C. The test pit and detailed topographic survey data were used to evaluate the depth and thickness of the native soil and to estimate the volume potential. A volume of 18,730 cubic yards was calculated using the Eagle Point prismoidal method. The potential borrow source area base topography and depth contours are presented in Figure 13-2.

Two composite native soil samples, 29-451-BS-1 and 29-451-BS-2, were collected to evaluate selected physical and chemical properties of the potential cover soil borrow source. Revegetation and particle size analytical results are summarized in Table 13-1 and the laboratory data are contained in Appendix B. The revegetation and particle size results indicate that the soils would meet the cover soil specifications (MDSL/AMRB, 1991) with the exception of organic matter content. The organic matter contained in the soils is 0.40 weight percent (wt. %). Some organic amendment may be required if this material were used as cover soil. To further assess the native soil potential as cover soil, quantitative laboratory analyses of the samples were done. The representative composite soil samples were analyzed for Ag, As, Ba, Cd, Cr, Cu, Fe, Hg, Mn, Ni, Pb, Sb and Zn. The laboratory reports are presented in Appendix B and the data are summarized in Table 13-1. The chemical results for this potential borrow source cover soil are comparable to the mean background soil concentrations determined for the Buckeye Mine site.



NO.	REVISION DESCRIPTION	BY	DATE

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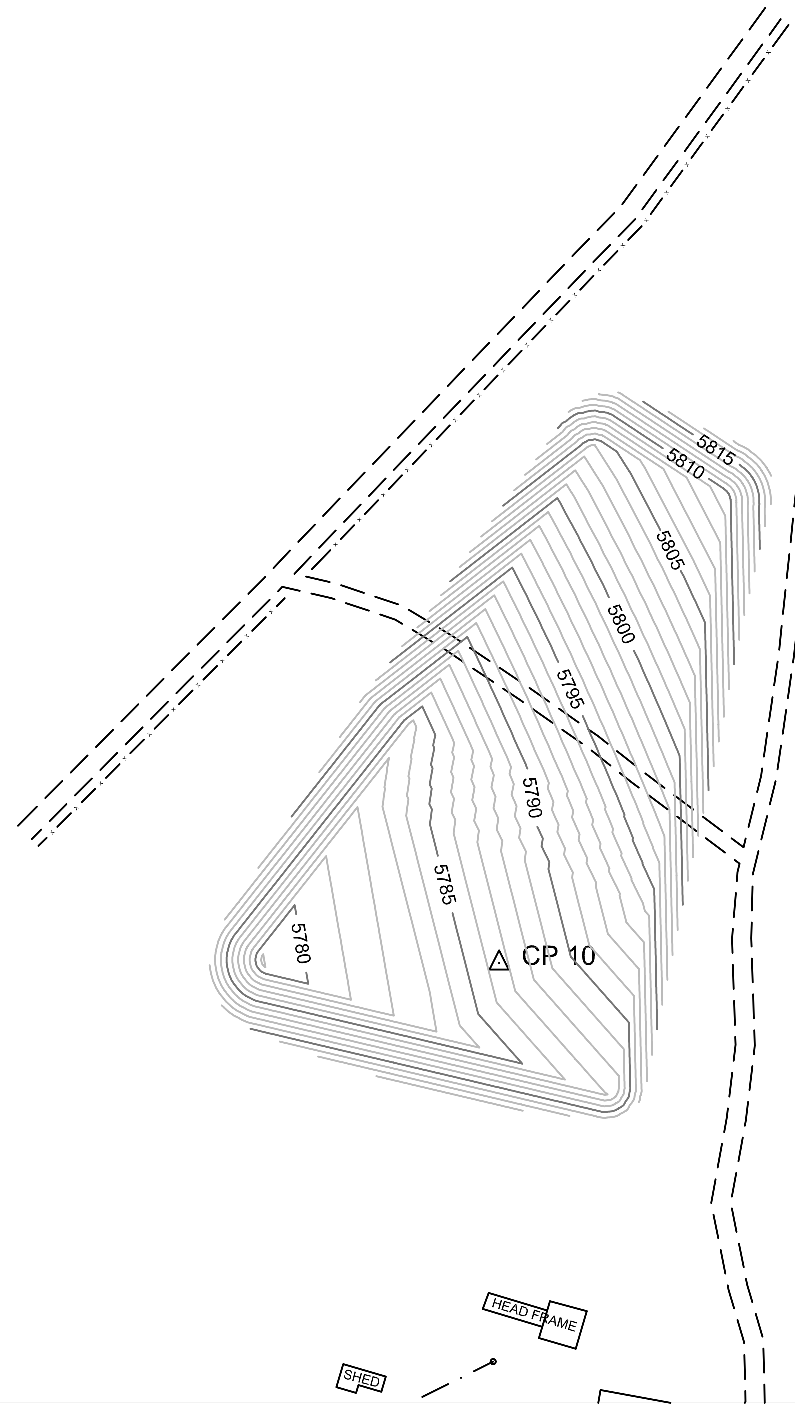
APPROVED: | DATE: 12/2004 | JOB NO: A1431
SCALE: AS SHOWN | FILENAME: A1431Buckeye.dwg

MONTANA DEQ/MINE WASTE CLEANUP BUREAU
BUCKEYE MINE SITE
MADISON COUNTY, MONTANA

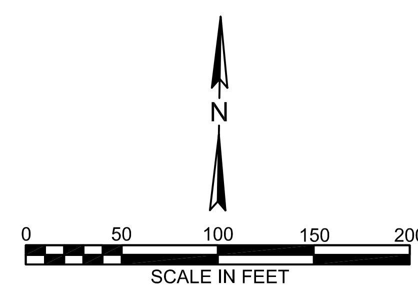
Olympus Technical Services, Inc.

BUCKEYE MINE SITE
POTENTIAL COVER SOIL BORROW SOURCE AND REPOSITORY AREA

FIGURE 13-1

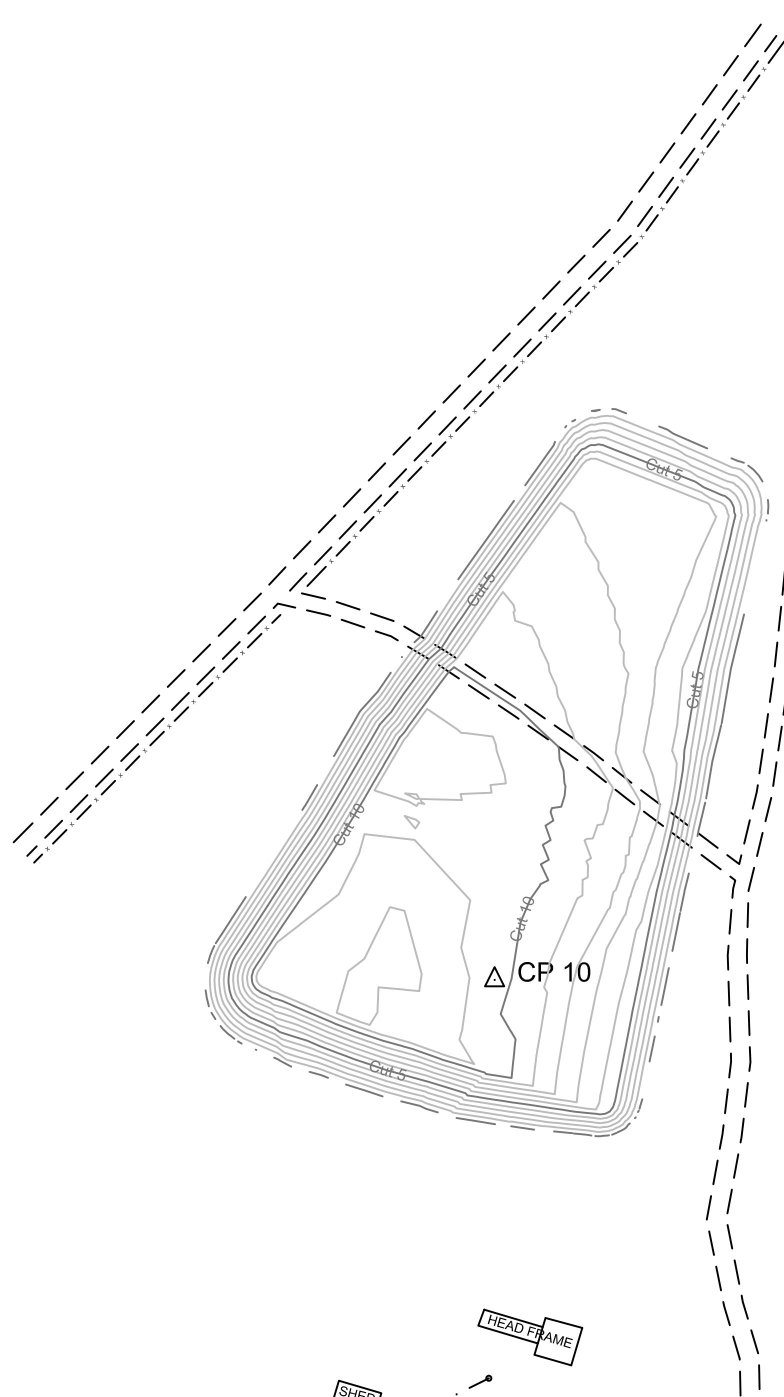


POTENTIAL REPOSITORY AND BORROW SOURCE AREA BASE TOPOGRAPHY

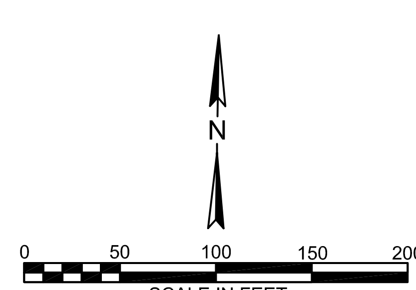


Prismoidal Volume Results

Original Surface Model:	Existing
Final Surface Model:	ReposBase
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	18726 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	18726 cu yd
Raw Fill Volume:	0 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	0 cu yd



POTENTIAL BORROW SOURCE DEPTH CONTOURS



Olympus Technical Services, Inc.	MONTANA DEQ/MINE WASTE CLEANUP BUREAU BUCKEYE MINE SITE MADISON COUNTY, MONTANA	POTENTIAL BORROW SOURCE AREA BASE TOPOGRAPHY AND DEPTH CONTOURS	FIGURE 13-2

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Table 13-1. Laboratory Borrow Source Cover Soil Revegetation, Particle Size and Chemistry Results

	Physical Characteristics				Chemical Characteristics						
Sample ID	Sand (wt%)	Silt (wt%)	Clay (wt%)	Texture*	pH (S.U.)	Conductivity, Saturated Paste (mmhos/cm)	Saturation (wt%)	Organic Matter (wt%)	Phosphorus mg/Kg	Nitrate as N (KCL extract) mg/Kg	Potassium mg/Kg
29-451-BS-1	48	35	17	L	8.0	10.0	33.4	0.40	13	<1	19
29-451-BS-2	30	52	18	SiL	8.0	8.77	41.4	0.40	14	<1	52

*C=Clay, S=Sand(y), Si=Silt(y), L=Loam(y)

Cover Soil Particle Size Results

	Weight Percent Retained					Percent Finer by Weight				
Sample ID	Gravel	Sand			Silt/Clay	Gravel	Sand			Silt/Clay
Sieve Size	3/4-in	#4	#10	#40	#200	3/4-in	#4	#10	#40	#200
Opening (Inches)	0.75	0.187	0.0661	0.0106	0.0029	0.75	0.187	0.0661	0.0106	0.0029
29-451-BS-1	<0.1	1.9	7.2	17.1	17.2	100	98.1	90.9	73.8	56.6
29-451-BS-2	<0.1	<0.1	0.2	2.4	16.0	100	100	99.8	97.4	81.4

Cover Soil Metal/Metalloid Chemistry Results

Sample ID	Ag (mg/Kg)	As (mg/Kg)	Ba (mg/Kg)	Cd (mg/Kg)	Cr (mg/Kg)	Cu (mg/Kg)	Fe (mg/Kg)	Hg (mg/Kg)	Mn (mg/Kg)	Ni (mg/Kg)	Pb (mg/Kg)	Sb (mg/Kg)	Zn (mg/Kg)
29-451-BS-1	<5	5.7	146	<1	19.0	49.3	17800	<1	352	17.0	36.9	<5	116
29-451-BS-2	<5	<5	178	<1	23.1	21.9	15700	<1	418	18.8	22.5	<5	67
Maximum	<5	5.7	178	<1	23.1	49.3	17800	<1	418	18.8	36.9	<5	116
Minimum	<5	<5	146	<1	19	21.9	15700	<1	352	17	22.5	<5	67
Mean		4.1	162.0		21.05	35.60	16750.0		385.0	17.90	29.70		91.5
# of Samples	2	2	2	2	2	2	2	2	2	2	2	2	2
Mean Background	2.5	9.0	167.3	0.50	21.7	40.2	17100.0	0.50	396.0	18.2	32.1	2.5	99.7

Note: Statistics - one half the lower detection limit is used where below detection limit samples are included in the mean calculation

LEGEND

29-451-BS-1 is a composite of BS-1-0-4.0; BS-5-0-3.6; BS-4-0-3.4

29-451-BS-2 is a composite of BS-2-0-11.7; BS-3-0-11.9; BS-5-3.6-6.3

14.0 POTENTIAL REPOSITORY SITE INVESTIGATION

The Buckeye Mine site is located at the southwestern edge of the Tobbaco Root Mountains near the area where Mill Creek discharges into the terraced valley northeast of Sheridan, Montana. The northern portion of the site is located in a moderately steep, narrow and mountainous ephemeral drainage basin, while the southern portion is located in the relatively flat floodplain of Mill Creek. Land ownership in the project area is mostly private on patented mining claims and these claims are generally bordered by public lands administered by the U.S. Bureau of Land Management (BLM). During the site characterization, a potential mine/mill waste repository site was investigated in the northern portion of the Buckeye Mine site. This area is located immediately to the north of the former Buckeye mill site at the same location as the cover soil borrow source previously described. This work involved assessing land ownership, estimating potential repository storage volume and preliminary design, construction logistics, and an evaluation of the subsurface geology and shallow groundwater.

Site characterization results indicate that the mill tailings (TP-1 through TP-5), waste rock piles (WR-1 through WR-5), and the Brandon Mill area wastes comprising impacted soils with lesser tailings and partially processed ore represent the most significant source of contaminants for impacting human health and the environment. The total estimated volume of the wastes associated with the Buckeye Mine is approximately 24,069 cubic yards.

Figures 13-1 and 14-1 show the potential repository site area, existing topography and preliminary repository design. This area was selected largely because it is an area on a relatively flat ridgeline and is strategically located to potential haul roads for transporting the wastes. The base of the repository would be constructed subgrade along the ridge top after the excavation of borrow source cover soils. The potential to use the same site for the cover soil borrow source and repository is advantageous for it would limit the land disturbance and provide for cost efficient construction. The borrow source and repository site would be located within the Buckeye patented claim owned by Victoria Mines, Inc.

The preliminary design indicates that the repository would occupy approximately 1.5 acres, have an average thickness of 11.6 feet, a maximum waste thickness of 16 feet, and a total repository height of 34 feet. The preliminary repository volume is estimated at 28,400 cubic yards. This is enough storage volume to contain the mill tailings, waste rock and impacted soils.

With the exception of slight moisture intersected below 4.0 feet in test pit BS-3, no other water was observed in the repository test pits. The geology of the repository area from the surface to depth consists of a thin topsoil layer, followed by light brown silty sand to sandy silt grading down to slightly oxidized, coarse sand and finally rock, probably bedrock. The maximum depth of unconsolidated materials was in test pit BS-3 where the total depth below ground surface was 11.3 feet. Shallow bedrock generally correlates with the ridge axis.

15.0 REFERENCES

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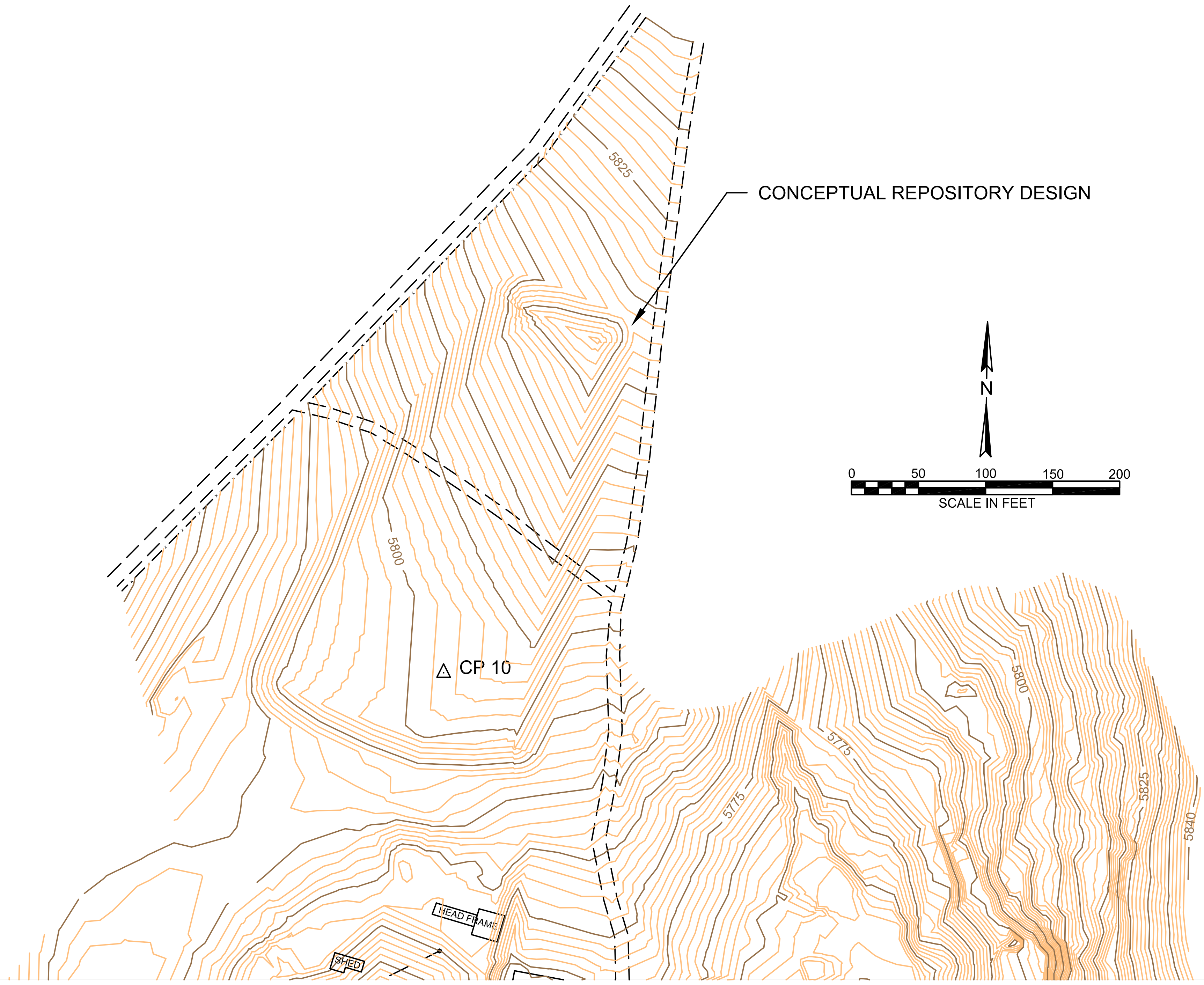
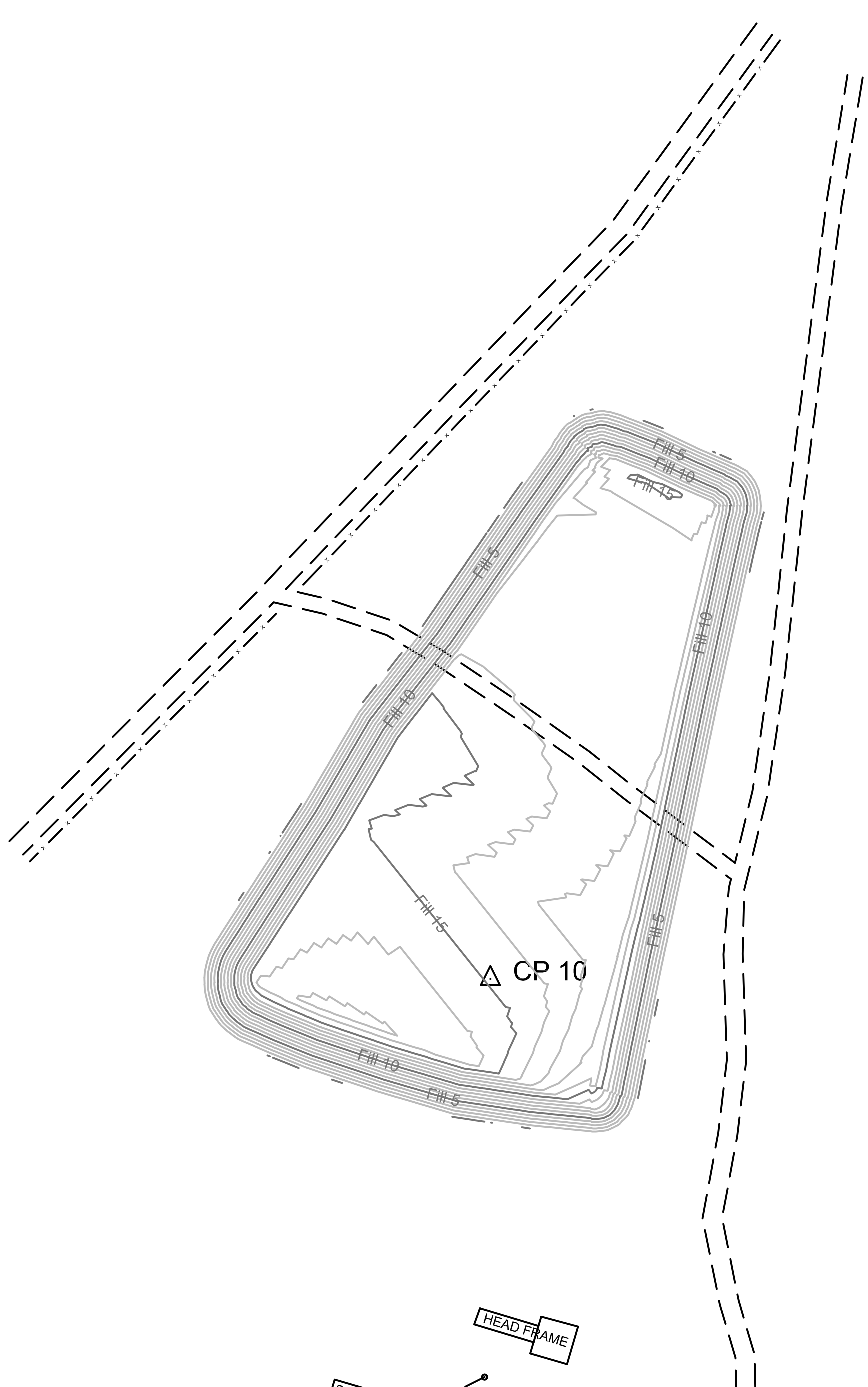
Cope, George F, 1888, Statistical and Descriptive Report upon the Mines of Madison County, Montana. Montana School of Mines. Butte. Typed copy made 1936.

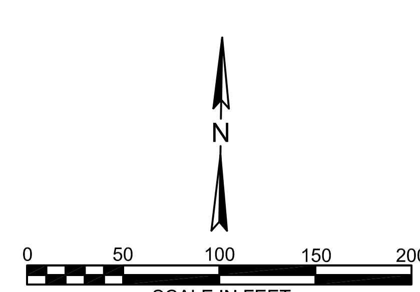




Prismoidal Volume Results

Original Surface Model:	ReposBase
Final Surface Model:	ReposTop
Cut Compaction Factor:	0.00 %
Fill Compaction Factor:	0.00 %
Raw Cut Volume:	0 cu yd
Compacted Cut Volume:	0 cu yd
Total Cut Volume:	0 cu yd
Raw Fill Volume:	28388 cu yd
Compacted Fill Volume:	0 cu yd
Total Fill Volume:	28388 cu yd

REPOSITORY DEPTH CONTOURS



Olympus Technical Services, Inc.				MONTANA DEQ/MINE WASTE CLEANUP BUREAU BUCKEYE MINE SITE MADISON COUNTY, MONTANA			BUCKEYE MINE SITE CONCEPTUAL REPOSITORY DESIGN AND DEPTH CONTOURS	FIGURE 14-1	
DESIGN:	DRAWN: KSR	CHECKED: CRS	APPROVED:	DATE: 12/2004	JOB NO: A1431	SCALE: AS SHOWN	FILENAME: A1431Buckeye.dwg		

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APPENDIX A

XRF ANALYTICAL RESULTS FOR THE BUCKEYE MINE SITE

APPENDIX B

LABORATORY ANALYTICAL RESULTS FOR THE METALS, pH, PARTICLE SIZE, ABA, TCLP AND REVEGETATION PARAMETERS FOR THE BUCKEYE MINE SITE

Appendix B

Tailings Samples:

29-451-TP1-1
29-451-TP1-2
29-451-TP1-3
29-451-TP2-1
29-451-TP2-2
29-451-TP3-1
29-451-TP3-2
29-451-TP3-3
29-451-TP4-1
29-451-TP4-2
29-451-TP4-3
29-451-TP5-1
29-451-TP5-2
29-451-TP6-1

Appendix B

Waste Rock and Brandon Mill Samples:

29-451-WR-1
29-451-WR-2
29-451-WR4-1
29-451-WR4-2
29-451-WR5-1
29-451-WR5-2
29-451-BM-1
29-451-BM-2
29-451-BM-3

Appendix B

Stream Sediment, Surface Water and Groundwater Samples:

29-451-SE1
29-451-SE2
29-451-SW1
29-451-SW2
29-451-SW3
29-451-GW1
29-451-GW2

Appendix B

Background Soil and Cover Soil Borrow Source Samples:

29-451-BG-1
29-451-BG-2
29-451-BG-3
29-451-BG-4
29-451-BG-5
29-451-BS-1
29-451-BS-2

Appendix B

Statistical Evaluation of XRF vs. Laboratory Analytical Method Results for Tailings

APPENDIX C

TEST PIT LOGS
FOR THE
BUCKEYE MINE SITE

APPENDIX D

MONTANA BUREAU OF MINE AND GEOLOGY GROUNDWATER INFORMATION CENTER WELL DATA SEARCH RESULTS FOR THE BUCKEYE MINE